LECTURES

ON THE

DEVELOPMENT OF THE

GRAVID UTERUS.

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BY

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DEDICATION.

TO

J. Y. SIMPSON, M.D., F.R.S.E.,

PROFESSOR OF MIDWIFERY IN THE UNIVERSITY OF EDINBURGH, ETC., ETC.

My dear Dr Simpson,

In issuing this little volume of Lectures, I gladly embrace the opportunity of dedicating it to you. During the time I had the privilege of acting as your Assistant I received many kindnesses, which I cannot hope to repay, but of which I have a most grateful recollection.

Foremost among the advantages which I derived from a residence with you, must rank the influence of your example, your zeal and energy, and your untiring industry. These could not fail to kindle in my mind an ardent love for our noble profession, and an earnest desire to further its objects by careful and accurate research. Many of the observations on the Development of the Gravid Uterus, which are embodied in the following Lectures, were made under your roof; and while I tender the result as an acknowledgment of how much I owe to you, I only regret it is so little worthy of your acceptance.

With every wish for your health and happiness, and hoping that you will long continue in a profession which your genius so eminently adorns—

Believe me,

My dear Dr Simpson,

Yours most faithfully,

WILLIAM O. PRIESTLEY.

PREFACE.

The following Lectures contain a summary of the more important researches which have been made on the development of the Gravid Uterus, together with the results of personal observations which I have ventured to incorporate with them. They were prepared for the Class at the Grosvenor Place School of Medicine, in the Session of 1858, and appeared subsequently in the *Medical Times and Gazette*. It has been suggested to me, that, if republished in a collected form, they might have a further use in facilitating the study of what is usually regarded as an intricate and difficult subject. I have therefore revised them, and made some additions to their original form without materially extending them.

Since the publication of William Hunter's celebrated work on the Gravid Uterus, the chief additions to our knowledge concerning it have been made with the assistance of the microscope; and the histology of the subject has received particular attention in these pages.

An apology for entering at length into minute details of the healthy structures in the Gravid Uterus may be offered in the fact, that we are yet very imperfectly acquainted with the morbid changes which occur in the reproductive organs in connection with pregnancy, particularly with those diseases of the ovum which lead to the early death of the embryo; and before we can enter upon their investigation, it is essential to have an intimate acquaintance with the appearances of the structures in their normal condition.

An endeavour has been made to divest the descriptions as much as possible of all ambiguity; and I have some hope that the Lectures

will be of service to students who, under the present regulations concerning Lectures on Midwifery, may have no opportunity of listening to anything beyond a mere outline of the subject of Uterine Development. For since the Examining Bodies have seen fit to limit the lectures on Midwifery to a course of three months—this course, including, as it does, not only Midwifery, but Diseases of Women and Children—every Teacher must find it impossible, with due regard to other important branches of obstetric education, to overtake the anatomical and physiological sections of the Course more frequently than once in two or three sessions.

In the choice of illustrations, it has not been thought necessary to reproduce those which can be found in William Hunter's plates, or in most of our standard works on Midwifery. Many of the drawings are taken from nature; and others, the sources of which are indicated, are copied from authors less generally accessible than the ordinary Text-books.

The formation and structure of the *corpus luteum*, although closely related to uterine development during pregnancy, has not been entered upon in detail, for the reason, that this was included in another Section of the Course. I cannot do better than recommend inquirers on this topic to Dr Montgomery's admirable work on the *Signs and Symptoms of Pregnancy*, or Dr Allen Thomson's article 'Ovum,' in the *Cyclopædia of Anatomy and Physiology;* and to original papers by Drs Paterson and Renaud, in the *Edinburgh Medical Journal*.

A list of the authors referred to throughout the Lectures is given at the end, together with an Index. In conclusion, I have much pleasure in referring those who seek further information on the Anatomy, Physiology, and Pathology of the Uterus, to Dr Arthur Farre's excellent article 'Uterus'—the last part of the *Cyclopædia of Anatomy and Physiology*.

31 Somerset Street, Portman Square,
November, 1859.

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LECTURE I.

Immediate Results of Impregnation—Formation and Structure of the Decidua—Nature of Dysmenorrhœal Membranes.

GENTLEMEN—To enable you the more readily to understand the changes which the uterus undergoes after impregnation, let me briefly recapitulate some of the points we have previously discussed, and place before you the physiological events connected with commencing pregnancy in the order of their occurrence. You will remember that I have already described to you the structure of the ovary, and pointed out that it is crowded with small closed follicles, termed Graafian vesicles, and that it has many characteristic resemblances to secretory glands in other parts of the body. Unlike other glands, however, it has no constant communication with a mucous or cutaneous surface, by means of a duct; but at certain seasons, termed periods of *ovulation*, which correspond with the ripening and bursting of one or more Graafian vesicles, the Fallopian tube fulfils all the purposes of a gland-duct, by seizing the ovary with the fimbriæ attached to its outer extremity, and completing its continuity with the cavity of the uterus. You could not fail to be impressed with the singularity of this phenomenon, so unlike anything witnessed in other parts of the body. The extremity of the Fallopian tube—lying, as it does, loose and apparently useless in the abdominal cavity, in the intervals between the ovular periods—as these seasons recur, suddenly rouses itself into activity; and with a precision,

which seems almost to indicate a separate intelligence, grasps hold of the ovary, as we grasp an orange with the hand, and receives the ova, as they escape from their follicles, safely into its trumpet-shaped infundibulum. I informed you that the apparatus by which this singular process is effected has hitherto been very imperfectly understood; but that latterly Mr Rouget has described a beautiful mechanism, consisting of muscular fibres in the broad ligament, and of erectile tissue in connection with the ovary itself, which has the power of bringing the ovary and tube together, and completing their union. How it is that ova are ripened only at certain regular periods, and what determines the fimbriated extremity of the Fallopian tube to grasp the ovary at those times, I told you we are yet ignorant, beyond the fact that the phenomena are in unison with a general law of periodicity, observed in the performance of other organic processes.

In following the ovum during its progress from the seat of its formation in the ovary, we first found it at the most prominent part of a ripe Graafian vesicle; to make its escape thence, it had to rupture both the special envelopes of the vesicle, and the two proper tunics of the ovary, and was then received into the trumpet-shaped end of the Fallopian tube, to commence its course along the oviduct.

I further explained to you, that, when no successful impregnation has taken place, the secreted ova escape from the body of the female —in the human subject—probably along with the menstrual discharge; while, on the other hand, when successful coitus has occurred, the ovum lodges itself in the cavity of the uterus, to be developed into the future fœtus, with its appendages of intra-uterine life.

When impregnation has been effected, the whole reproductive system assumes a new and increased vigour and development; the ovary itself partakes in this, and the Graafian vesicle or vesicles, which, without impregnation, collapse, and undergo a retrograde process after emitting their germs, continue to be developed in such form and manner as to give rise to the structures in the ovary, which are called corpora lutea.

The ovum commences its journey from the ovary towards the uterus as an extremely minute vesicle, surrounded by a microscopic clear ring, called the zona pellucida, and having adhering to it shreds or particles of the tunica granulosa or lining of the follicle, which surrounded it before it quitted the Graafian vesicle.

Instances are extremely rare in which the ovum has been detected in the Fallopian tube of the human subject. It is so minute as to need a microscope for its proper definition, even in the Graafian vesicle, and it may be readily overlooked when mixed with the secretion of the canal, and its exact position not known. Observations on this part of its course have, therefore, been chiefly confined to the lower animals; and the celebrated Bischoff, Martin Barry, and others, have here studied it most carefully. In the bitch and rabbit, the ova appear to the naked eye like extremely minute white specks, passing in succession along the tube, propelled, apparently, by the vermicular contractions of its muscular coat, and assisted, probably, by the cilia of the epithelium lining the canal, which cause a current in a direction towards the uterus. The time occupied by the passage of ova along the Fallopian tube varies in different animals, and, perhaps, in different individuals of the same species, influenced by circumstances of which we are not cognizant. In the bitch, the ova remain in the tube eight or ten days before entering the uterus; in the guinea-pig, they reach the inner termination of the duct in three or four days; in the human female, the ovum has been so seldom found in the tube at all, that we have no very accurate data to determine the length of time occupied in its transit. From various collateral circumstances, it is supposed to be present in the tube seven or eight days after fecundation. The passage of the ovum through the Fallopian tube possesses increased interest from the probability which exists, that here it encounters the seminal fluid from the male, and that thus impregnation takes place. Bischoff, Wagner, and Barry, in numerous experiments, found active spermatozoa occupying the Fallopian tube, and Bischoff found them as far as its distal extremity, and even upon the surface of the ovary itself. None of the observers I have mentioned, however, seem to have noticed the penetration of the spermatic animalcules into the Graafian vesicles of the ovary; and, therefore, it is regarded as most probable that the union of the sperm and germ cells, which is necessary for successful impregnation, does not take place until the Graafian vesicle has ruptured and discharged its contents into the Fallopian tube.

Supposing, then, that we have a successfully impregnated ovum passing along the Fallopian tube towards the uterus, before tracing it further, let us look to the preparations which are being made for its reception into the cavity of the womb. Before the fertilised ovum reaches the uterus, the mucous membrane lining its inner

surface, partaking of the increased vitality in the entire genital apparatus, becomes more vascular. Consentaneously with the increased supply of blood, all the elements in the mucous tissue become more developed. The quantity of epithelium and other elements are so increased, that the entire mucous membrane of the fundus and body of the uterus forms a thick pulpy layer, and acquires a disposition to shed off from the fibrous structures beneath. This phenomenon is the more remarkable, as you will remember, in the unimpregnated state, the mucous membrane was so closely adherent, as to be almost inseparable from its subtending elements. The pulpy membrane thus formed, by a transformation of the mucous membrane, is intended as a covering for the ovum when it arrives in the uterine cavity, and is known as the *membrana decidua* of Hunter, or the external envelope of the fœtus *in utero*.

Previous to the time of William Hunter, no author seems to have distinguished the decidua from the rest of the coverings of the fœtus, and to this celebrated observer is undoubtedly due the merit of discovering its existence as a special membrane, having its origin in the uterus, and being present there before the arrival of the embryo, with its own special ovular tunics. Since Hunter's time it has received much attention, and many and various have been the names applied to it by different authors. Indeed, the diversified nomenclature of the decidua may considerably embarrass you in reading English and foreign works on midwifery, unless you are acquainted with the variety of synonyms under which this membrane is made to appear. For instance, while Hunter applied to it the term Membrana Decidua, Osiander calls it the Membrana Mucosa; Danz, the Membrana Cadnea; Burdach, the Nidamentum; Breschet, the Perione; and Velpeau, the Membrana Anhisté, the last involving the erroneous theory that it is destitute of vessels.

Opinions have differed from time to time as to the origin and nature of the decidua. Millot, a French obstetrician, who flourished fifty years ago, supposed that the union of the male semen with the mucous of the womb, gave rise to a consistent layer, which spread itself over the inner surface of the uterus, and afterwards acquired vessels in its structure. The famous John Hunter at one time described it as an inflammatory product, thrown out upon the inner surface of the uterus, and resembling the membranous exudations of croupy inflammation in the windpipe. In another place, he speaks of it as formed of coagulated blood, with blood-vessels penetrating it, after the fashion in which blood-vessels penetrate,

or seem to penetrate, an apoplectic clot in the brain. His elder brother, William, however, held a different opinion, and seems, even at that time, to have comprehended the true nature and origin of the decidua. We give him credit not only for discovering the existence of this membrane, but also of indicating its true source. And while speaking of William Hunter, I cannot refrain from pausing for a moment to pay a just tribute to his genius and sagacity. It is the fashion among scientific men in our own days to extol the name of John Hunter, as one of the greatest men of his time, and well his name deserves all the eulogiums which can be bestowed upon it; but, in looking carefully into the labours of his brother William, one is often tempted to think that, although his pursuits may not have been so varied and extensive as those of his more celebrated brother, yet, for profundity of observation and true sagacity, he was in no respect his inferior.

William Hunter's opinion was, that the decidua really consists of the hypertrophied mucous membrane, or "inner lamella of the uterus." In an account of it, written about the time he published his magnificent plates of the "Gravid Uterus," he repeats this opinion on more than one occasion. It is the more important to be clear on this point, as we shall see presently, that very important and comparatively recent researches undoubtedly prove William Hunter's account to have been the correct one.

That the decidua is an uterine product, and not brought by the ovum, when it first makes its appearance in the uterus, is proved by a variety of circumstances. In the first place, The researches of Baer and Weber have proved that it is present in the uterus in the first week of conception, before the ovum has quitted the Fallopian tube. Secondly, It has been observed to exist in the uterus in a considerable number of cases, in which the ovum never reached its cavity, as in the instances where it was developed in the Fallopian tube, or in some extra-uterine position. Thirdly, It is supplied with nutrient vessels, arising directly from the uterine parietes, while the fœtus and its immediate dependencies have a circulation peculiar to themselves, and apart from the maternal system. Lastly, The similitude the entire membrane bears to the shape of the uterine cavity, and the histological elements which compose its intimate structure, as ascertained by the microscope, seem definitively to settle the question.

Dr Robert Lee, who has paid great attention to the subject of ovular development, dissents from this view of the origin of the

decidua, on the ground that a decidua is found surrounding the ovum in extra-uterine pregnancies, while it is sometimes at least absent from the uterus in these cases. He doubts, indeed, the evidence adduced to prove that the membrana decidua is ever found in the uterus under such circumstances. His objection, however, seems to me not to affect the proofs of the fact, that the mucous membrane is transformed into a decidua whenever the ovum is developed in the uterine cavity, as in normal pregnancy.

The decidua, when first formed, is a hollow sac of triangular shape, corresponding to the form of the uterine cavity. It has a little cornu at each of its superior angles, resulting from its prolongation a short distance along each tube of Fallopius. Inferiorly it does not extend lower than the os internum, no portion of it occupying the cavity of the cervix. A plug of thick tenaceous mucus, secreted by the glands peculiar to that situation, fills the canal of the cervix uteri, and acquiring, in some cases, a firm consistency, when abortion occurs, it becomes covered with coagulated blood, and adheres to the lower angle of the decidua. It thus, in the early weeks, looks like an appendage or tail to that membrane (see fig. 1). This cervical mucus, however, never acquires the same high organisation as the decidua itself, and subsequently disappears.

The question of the number of openings into the decidua, or whether any are present at all, has been warmly disputed. William Hunter has described and figured it with three, corresponding to a deficiency at each Fallopian tube, and at the cervical canal. Dr Robert Lee describes only two apertures at the situation of the superior angles or Fallopian apertures. Burns and Carus, again, only admit one orifice, existing occasionally where the cervical canal terminates; and, lastly, Lobstein and Moreau contend for no openings at all—the decidua, before the arrival of the ovum, being a perfectly shut cavity. The explanation of these discrepancies by Wagner, while it reconciles these various opinions, seems intelligently to decide the matter. This celebrated physiologist tells us, from his own experience, that it depends entirely upon the secretion to form the membrane being sparing or copious, whether one or more openings are readily apparent, and that if the layer is thick and luxuriant no aperture may be detected at all.

If you are fortunate enough to obtain possession of a recently formed decidua, and place it under water, you will find that its outer surface, which has been next to the muscular coat of the uterus, is everywhere uneven and shaggy—small flocculent particles

appearing torn and half-detached from the lamina itself, and floating out in the fluid in which the preparation is immersed. Since the decidua has been acknowledged to be the altered uterine mucous membrane, these flocculent projections have frequently been described as glandular tubules dragged out of those uterine structures upon which the decidua had immediately rested. Frequent examination has, however, convinced me that they only occasionally consist of tubes formed of epithelium, by far the greater number of these filamentous processes being minute shreds of the fibro-cellular structures, which form a large proportion of the deeper layers of the decidua, and which I shall describe more fully presently. The real gland-tubes are most of them broken off close to the surface of the membrane, and may be discerned occupying the centre of little eminences, separated from each other by grooves or shallows. Bisecting one of these eminences, the aperture seen upon it externally is observed to lead to a small dilatation or cavity filled with a milky fluid. These cavities were first described by Dr Montgomery of Dublin, and are known among obstetricians as "Montgomery's Cups."

Making an incision now through the entire thickness of the

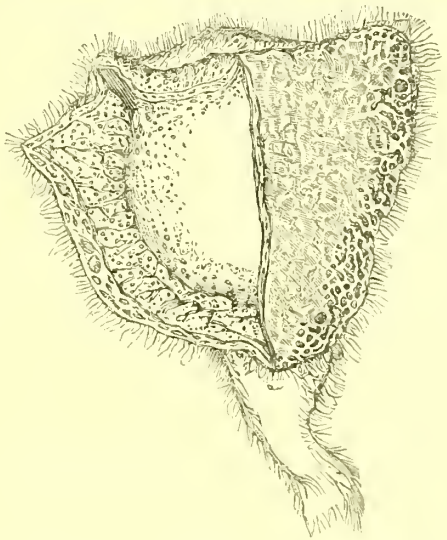

Fig. 1.

An aborted ovum of about fifty days, one-half of the decidua uteri is opened and thrown back to shew the decidual cavity, and the decidua ovuli—dotted over with glandular apertures—enclosed within it. The tail-like process is a coagulum formed round the cervical mucus, and adhering to the lower angle of the decidua uteri. After Coste.

lamina, we expose the decidual cavity, and note its triangular form. The internal surface, unlike the external, is perfectly smooth, like a mucous, or, rather, like a serous, membrane. It is thrown into slight folds, as though the sac had been somewhat too capacious for its containing limits; and, looking at it carefully with the naked eye, or, better still, with the aid of a common magnifying lens, numerous minute pits or depressions are found studded over the plane of its surface. These depressions are the secreting orifices of the diluted ducts we saw broken off externally. It is believed that they communicate outwards with the minute sacs described by Dr Montgomery, being thus glandular tubules with a contracted orifice, and a pouch-like dilatation beyond this. Employing now a higher magnifying power to sections made with a knife or scissors, the tubes are seen to be filled with secretive epithelium, which extends throughout the canals, and so fills the dilated portions as to give rise to the appearance of the milky fluid before mentioned. The epithelial particles on the surface are not of the cylindrical kind, but seem to be at first irregularly spheroidal, and then flattened by pressure from the rapid development beneath (see fig. 2 *a*). The glandules of the uterine mucous membrane, which consist of simple and more tortuous follicles—by no means easily demonstrated in the unimpregnated uterus—after conception become so developed and prominent, that the decidua really consists in a great portion of readily discerned gland-ducts, united together by inter-follicular nucleated cells, cell fibres, and molecular particles.

Taking a portion of a somewhat more advanced decidua, and spreading it out with needles for the microscope, it is observed to be readily separable into irregular portions, or fragments, with clear interspaces, very much, in fact, like a web or net-work, formed by the super-position of several layers of a cribriform membrane one upon another. The appearance of wide interspaces, and of a tendency to separate in certain directions, is more marked in the second and third months of pregnancy than in the first month. It probably results from the greater widening of the tortuous glands and the remarkable increase of their epithelial contents. Nucleated cells of a rounded or oval form are found occupying these interspaces, but the tubular canal is seldom retained in distinct outline. The parenchemytous structure in the superficial layers looking towards the inner surface of the decidua consists of flattened epithelial cells of somewhat irregular shape, in super-imposed layers, and imbedded in an amorphous material; the cylindrical

and ciliated kind which lines the interior of the uterus being apparently shed off as soon as impregnation has been effected, and

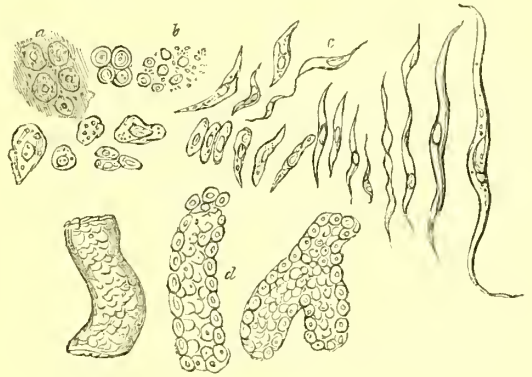

Fig. 2.

a, epithelial particles imbedded in an amorphous matrix, forming the smooth inner surface of the decidua; *b*, molecular particles and cells mixed with; *c*, elongated cells and fibres from the deeper layers; *d*, tubular portions of epithelium from enlarged follicles in a decidua of the second month.

the succession of cells immediately beneath assuming a rounded or pavement form, probably for the purpose of constituting a membrane firmer in texture. Directly beneath this superficial layer are found caudate cells, with molecules and fat granules and cell fibres, undergoing all the transformations from dormant cell forms into genuine fibres, such as are observed in the organisation of plastic lymph. Generally, the farther pregnancy is advanced, and the nearer we approach the muscular coat of the uterus, the more are these fibres developed, and of greater size, until they mix at certain points by insensible gradations with the muscular fibres, and cannot readily be distinguished from them. In the third and fourth months of pregnancy, fibres of various sizes, with an elongated nucleus, and often arranged in a linear series, may be found mixed up everywhere with the cellular and molecular element; the fibres in the deeper layers seem to have an irregular disposition around the dilated gland-ducts, and may possibly be endowed with some contractility, thus giving rise to the appearance of sinuosities on the dorsal surface of the envelope—the prominences being a glandular and non-contractile element, the furrows or sinuosities being the situations occupied by the surrounding fibres.

The blood-vessels of the decidua are derived from the uterine walls, and consist, in the early weeks, of a net-work of capillaries.

forming, according to Professor Goodsir and M. Coste, polygonal meshes in the inter-follicular substance. In the deeper layers elongated meshes are found, formed chiefly by straight vessels branching dichotomously and anastomosing freely. These may be seen ramifying on the dorsal surface of the membrane, and penetrating its structure, in most very young ova recently expelled. If development be further advanced, the blood-vessels are larger, and where they have been torn across in the separation from the uterus, they appear as open-mouthed canals entering the outer surface of the decidua obliquely, among the glandular tubules before described, and distinguished by their thinner coats, and the absence of a glandular lining.

A point of no little interest to the practitioner in connection with the structure and formation of the decidua is, that a membrane, in most respects identical with that membrane, so far as I have yet described it, may be formed and thrown off from the uterus as the product of diseased action, and without any sexual intercourse having ever occurred. Were you ignorant of the fact that substances may be expelled from the uterus, independent of impregnation, which bear a close resemblance to the products of conception, you may be led into the serious error of impugning the character of an innocent person, and, perhaps, bring discredit on yourselves. False deciduæ, which are called the membranes of dysmenorrhœa, are separated from the uteri of certain patients who suffer from painful menstruation, both before and after marriage. The suffering which accompanies the expulsion of these substances, in a patient I lately attended, was sometimes so intense as to be compared to the pains of labour; and in many cases the pain is not confined to the actual menstrual period, but encroaches more or less on the intervals, and seriously affects the general health of the subject of it. The membranes thus discharged with the menses are most frequently in shreds or fragments, with a rough villous external, and a smooth internal surface. Occasionally, however, they are expelled quite entire, and in shape bear the impress of the triangular form of the uterine cavity, the openings corresponding to the Fallopian tubes, and cervical canal being discernible. Sometimes I have seen the cavity of the membrane filled with coagulated blood, layers of fibrin so obscuring its real structure that it was demonstrated with difficulty. They were long supposed to consist of the products of inflammation, and to be formed of coagulable lymph exuded from the uterine internal surface. In 1846, how-

ever, Professor Simpson first shewed that they consisted of the exfoliated mucous membrane itself, and, in all respects, were

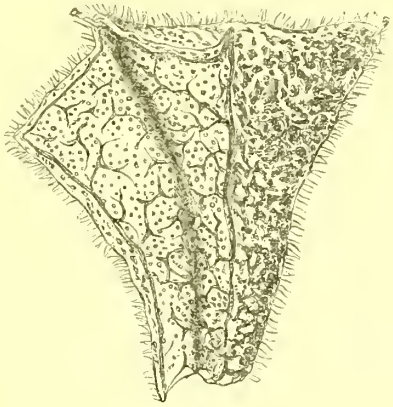

Fig. 3.

A dysmenorrhœal membrane expelled from the uterus of an unmarried woman, shewing the follicular apertures on the internal surface, and the openings corresponding to the Fallopian tubes. (From M. Coste.)

identical with the newly-formed decidua, except in the absence of impregnation as an exciting cause. Later, M. Lebert and Dr Handfield Jones have furnished additional proofs of the truth of Dr Simpson's position. I have frequently had opportunities of examining these dysmenorrhœal uterine casts, and have found them in some cases where they were tolerably complete, to consist of a mere film or transparent membranous sac, the structure of which was resolved under the microscope into layers of flattened epithelium ; at other times they have consisted of cylindrical epithelium, such as we find on the mucous coat of the unimpregnated

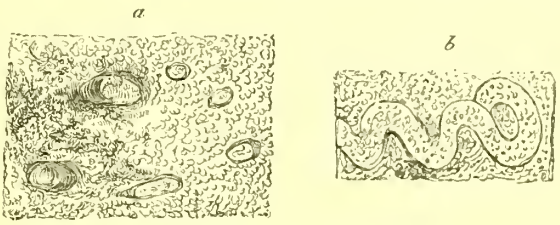

Fig. 4.

a, Enlarged glandular apertures visible on the inner surface of a dysmenorrhœal membrane.
b, A contorted duct, lined with epithelium, seen in section, mag. 190 diam.

uterus. In several instances, the triangular pouch extruded, had walls of a line or more in thickness, and of spongy texture. Rounded or oval apertures were scattered over the smooth internal surface, corresponding to a certain number of dilated glandular openings, but these were somewhat less numerous, and wider apart than in the decidua of pregnancy. In sections, I was able to demonstrate portions of glandular tubules formed of epithelium, and occasionally an unbroken secreting duct appeared in the field of the microscope, with a corkscrew-like outline, not unlike a sweat-duct. Considerable vessels, according to Virchow, are sometimes found in these preparations.

LECTURE II.

Decidua reflexa or Ovuli—Changes in the Deciduæ during advancing Pregnancy—Pathology of the Deciduæ.

To return to the ovum, which we left passing onwards in the Fallopian tube towards the uterine cavity, where active changes have in the meantime taken place. At the inner extremity of the tube, it necessarily encounters the new-formed uterine decidua, but what relation it takes to that lamina when it emerges from the oviduct is yet a debated question, and one on which the most discordant opinions have been held. This discrepancy of opinion has arisen from attempts to account for the fact noticed by nearly all observers, that in dissections of ova found in the womb early in pregnancy, the fœtus has been found to be wrapped in *two* deciduous coverings instead of a single one, as might have been expected, if the ovum had dropped simply into the unaltered decidual chamber, as into the mucous cavity of the womb. In the second and third months of gestation, indeed, besides a layer of spongy tissue, which adheres closely to the uterine parietes, and corresponds to the mucous membrane, a second layer interior to this, of almost identical histological structure, closely envelops the ovum—a cavity or interspace intervening between the two, except at one portion equal to a third of the whole circumference, where they coalesce, and together are united to the uterine walls. The innermost of these two decidual laminæ was first described by William Hunter, and named by him the decidua *reflexa*, in contradistinction to the outer, which he called the decidua *vera*. They are best designated, however, as the parietal or uterine decidua, and the ovular or chorial decidua, as suggested by Dr Baillie, these terms involving no theory, and simply expressing their anatomical relations. To account for the presence of the ovular layer, Burdach, Velpeau, and many other obstetric physiologists, while they believe it to be of uterine origin, hold that the ovum does not enter the sac of the first formed decidua, but, encountering some portion of its outer surface when it emerges from the Fallopian tube, that it pushes it before it like a double night-cap, and becomes enveloped in a

reflected membrane, exactly as the lung is surrounded by two layers of the pleura, but is yet outside its serous cavity. MM. Coste, Breschet, and Dr Sharpey, discarding this hypothesis, contend that the ovum enters the cavity of the decidua, sinks into a fold or follicular orifice, and that the decidua ovuli or reflexa is simply a process of the latter developed around the germ to fix it in position, which at last so far grows over it as to envelop it completely. Dr Robert Lee has published an account of a dissection, the peculiarities of which were such as to leave no reasonable doubt that the ovum had entered the cavity of the decidua, and had not reflected a portion of the wall before it. In this case, the ovum had attached itself to the lower portion of the uterine cavity, where it was closely enveloped in an ovular decidua, and external to this was a parietal lamina which adhered to the uterine walls. A space or deep groove intervened between the attachment of the ovum and fundus uteri, the young placenta being planted over the cervical canal. At the upper angles of the decidual chamber, the orifices of the Fallopian tubes were quite distinct, and not displaced, as they must have been had the ovum inverted the membrane by pushing it before it. A great objection to the theory adopted by M. Coste and others, who hold modified views of the same kind, exists in the fact pointed out by Professor Weber and M. Robin, that, when examined, the decidua ovuli exhibits over its entire outer surface, or at least the greater portion of it, the same pits or depressions which are found on the opposed or inner surface of the decidua uteri, and which there indicate the orifices of glandular tubules (see fig. 1). Moreover, the canals which these depressions lead to, have many of them a direction at right angles to the surface, and they are paved with nucleated epithelium, as in the outer decidua. It is quite incomprehensible that the entrance of the canals should have this relation to the surface, and occupy so large an extent of it, did the decidua begin to vegetate round it from a small and localised spot. Besides, so far as I am aware, no one has ever observed the ovum resting in a cup-shaped growth of the primary decidua, or in any of the intermediate stages of growth, short of complete inclusion, if we except a small deficiency described by M. Coste as sometimes found in the decidua ovuli at its most prominent portion, and which may have been produced by the distention from within. I feel disposed, therefore, to accept as more probable a suggestion thrown out by Weber, and which corresponds closely with the opinion formed by Mr Goodsir, that the decidua reflexa or

ovuli is actually the primary lamina secreted before the ovum enters the uterus, which separates in two-thirds of its extent from the layers immediately beneath it, to adhere to the ovum and retain it in position; the remaining third not separating, but remaining as a centre of nutrition by its union with the womb.

The parietal decidua, therefore, should be regarded as a subsequent formation on the uterine walls, or a deeper layer, secreted after the manner of the previous growth. In support of this view, I may adduce what I have just now mentioned, the direct entrance of the glandular apertures on the outside of the decidua ovuli, and their presence over all, or most of its surface, as affording a strong presumption of a separation having taken place from a deeper layer. In addition to this, we have evidence of the fact that the mucous membrane of the uterus has a tendency to shed off its superficial cells periodically, when they appear as epithelial *debris* in healthy menstrual discharge, or under certain morbid conditions as a continuous layer, called the membrane of dysmenorrhœa. The tendency of the mucous membrane of the uterus to shed off periodically accounts, indeed, in some measure for the known tendency to abortion at the menstrual epochs; and physicians generally recommend perfect rest to the subjects of early miscarriage, as each lunar month approaches, to prevent detachment. Wagner hints at the probability of there being only one decidua in very early pregnancy, and figures an ovum of twenty-one days, but which may have been of an earlier date, which he believed to be perfectly normal and complete, and in which only one decidual envelope existed. I think I have seen, on two or three occasions, a very early aborted ovum, bearing the triangular form of the uterine cavity, and in which there was apparently only one decidua; but this with care might be separated into two distinct laminæ, with smooth opposed surfaces, shewing the first indication of a decidual cavity. It may possibly be objected that the small size of the ovular chamber, in the earliest instances where an ovum has been discovered in the uterus, bears no sort of proportion to the general size of the uterine cavity; and, therefore, it is necessary to suppose, in such cases, as the one figured in the beautiful atlas of M. Coste—where, at about the twentieth day of gestation, the decidua ovuli enclosing the embryo was discovered as a small soft tumour, projecting above the surface of the decidua vera—that a dissepiment must have sprung up to make a partition from the general cavity. M. Cazeau, however, remarks that, "on account of the swelling of the mucous

membrane, its cavity is almost obliterated, and the ovule is consequently supported between two opposite points of the hypertrophied and softened membrane. Therefore it rarely progresses very far, and becomes fixed upon the fundus." This statement, while it accounts for the general attachment of the ovum in the upper segment of the uterus, seems to me to dispose of any objection which may be founded on the apparent want of correspondence between the capacity of the ovular chamber and the cavity of the uterus before impregnation.

To account for the presence of the decidua ovuli is a subject of acknowledged difficulty, and some facts may yet appear which are irreconcilable with the above hypothesis; but, in the meantime, I am inclined to think it the more probable one. No decidua reflexa exists in the gravid uteri of the lower animals, and, therefore, we can draw no analogical inferences from observations in Comparative Anatomy.

But to proceed: The ovum is enveloped in about two-thirds of its circumference by two laminæ of uterine origin, called respectively—the first, the parietal or uterine decidua; and the second, the decidua reflexa or ovuli. In the remaining third, the two decidua coalesce, and, forming together a thick intervening layer between ovum and uterus, bind them mutually and closely to each other. At this spot is formed the *placenta*, and round the circumference of it, as you look into the decidual chamber, the smooth lining of the parietal decidua seems reflected to the ovular layer. By those who look upon the ovular decidua as a reflected membrane, the intervening portion, where the placenta is developed, is supposed to be a later secretion than the rest, formed to supply the place of that part of the decidua pushed before the ovum, and of which the uterine parietes had been denuded at the time of reflexion. It is thus called the decidua *serotina*. Adhering to the explanation previously given, the serotina would be looked upon simply as a coeval portion of the original mucous lamina or decidua, which has not separated from the subjacent tissues, but remains to keep up an organic connection between fœtus and mother.

Laying open now the decidua ovuli by an incision, we come at once upon the ovum (see fig. 5, *d*), wrapped in two special membranes of its own, called the *chorion* and *amnion*. The most external of these, the chorion, is covered externally with little feather-like processes, called *villi*, and, under water, it reminds one, at a very early stage, of a little ball made of swan's down, with its feathery projections pointing outwards in every direction. The

villi serve the purpose of rootlets to the young embryo, and, by pushing themselves into the substance of the decidua, fix the ovum,

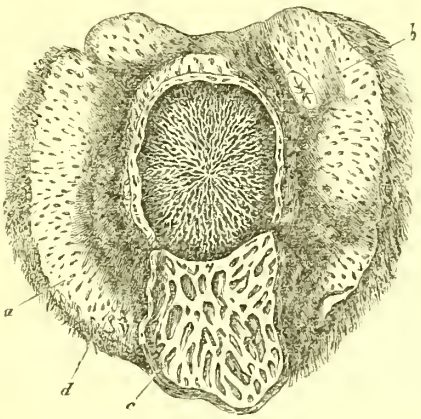

Fig. 5.

An ovum removed from the uterus, and part of the decidua uteri cut away; *a*, decidua uteri shewing the follicles opening on its inner surface; *b*, the inner extremity of the Fallopian tube; *c*, a flap of the decidua ovuli thrown down, shewing the depressions for the villi on its internal surface, and exposing *d*, the chorion, or first true fœtal envelope. (After Coste.)

and carry on the process of inbibition from the maternal capillaries. If you separate the chorion from the decidua ovuli, by pulling away the villi from the attachments they have formed, the inner aspect of the ovular decidua is observed to be marked with depressions or lacunæ of an irregular form, and these again lead to tortuous canals, deeper in the tissue, which have been occupied by the villi of the chorion, and correspond to their irregular windings. We possess no very accurate observations as to how the villi first behave themselves when striking root into the decidua of the human subject. Dr Sharpey, however, made a most interesting investigation of this stage of development in the bitch, and suggests a similar mode of growth in man. He first points out that the mucous membrane of the bitch's uterus possesses glandular follicles opening on its free surface. At the time of impregnation these enlarge and form little saculi just beneath the surface, with contracted orifices, the whole internal coat becoming highly vascular and greatly increased in thickness. When the ovum arrives in the uterus, it throws out the villous processes of the chorion, which enter these apertures, and absorb nourishment for its maintenance and growth. The mucous membrane thus becomes the decidua,

which is shed off at the time of delivery, and no lamina corresponding to the decidua reflexa is present. Reasoning analogically, we may presume that similar phenomena take place in our own species. We can demonstrate the sacules or reservoirs of nourishment in the decidua, known as Montgomery's cups, which are formed by a dilatation of the follicles in the mucous membrane, and at a later period form wide interspaces in its tissue. Further, we know that the villi of the chorion penetrate the decidua, and become imbedded in its substance, but we have no distinct evidence that the chorion sends its rootlets directly into the dilated glandular apertures; and Schroeder van der Kolk, a celebrated Dutch observer, believes, from personal observations of his own, that the villi do not enter the dilated gland-ducts. In ova of different ages I have repeatedly

Fig. 6.

Terminal villi of the chorion imbedded in the substance of the decidua ovuli near the placenta, surrounded by a halo of clear cells, from an ovum at the end of the second month. Mag. 190 diam.

sought for indications of the different stages of growth of the villi into the glandular follicles, and I have never yet been able to discover one of these offshoots partially projected into a gland-duct, as might be expected in the earlier stages of growth. The extremities of the villi have always appeared to me to be imbedded in the parenchymatous substance of the decidua, surrounded by a halo of clear cells, which may be the glandular epithelium of a follicle; but, if so, the villi have completely filled the gland-duct to its termination, no part of its extent being left unoccupied (see fig. 6).

The space between the decidua uteri and ovuli varies at different periods of gestation. If we adopt the view that the decidua ovuli is really the originally formed decidua, the two layers must have been in close approximation in the earliest days after conception.

The cavity of the decidua is, however, quite distinct in the latter part of the first month, and perhaps becomes so soon after the ovule enters the uterus. It then contains a small quantity of pink serous fluid, called the *hydroperione* by Breschet. The uterine walls at this time becoming more rapidly developed than the ovum, recede from it, and carrying outwards the deeper layer of the mucous membrane, which thus constitutes the parietal decidua, leave the superficial lamina adhering to the ovum as the d. ovuli, and a space existing between the two. In the fourth or fifth month, the two deciduæ again became closely approximated by the increased growth of the ovum, the cavity which separates them, with its contained hydroperione, disappear, and the membranes are so closely united as to be generally inseparable at the time of delivery. As the ovum increases in size, and encroaches on the decidual cavity, it gradually stretches and thins the decidua ovuli, until it erases from its most prominent portion both the glandular apertures and the capillary net-work, which were visible at a somewhat earlier period. The openings of the gland-ducts may, however, be found later in considerable numbers, and of large size, concentrated, near the point of reflexion to the parietal layer, round the base of attachment to the uterus. At the point of greatest projection, prior to its coming into apposition with the parietal layer, the ovular lamina becomes reduced to a mere film, and a small aperture or breach of continuity is sometimes observable. M. Coste has drawn particular attention to these appearances, as supporting the theory he promulgates concerning the formation of the decidua ovuli. He regards the thin spot in the centre of this lamina as indicating the recent closure of a fold of the decidua round the ovum, and the small aperture sometimes found, which he designates an *umbilicus*, he looks upon as the stage anterior to complete inclusion. He does not, however, describe any intermediate stages which distinctly prove his position, and it is to be remarked that the thin spot alluded to is largest in the more advanced ovum.

Dr Robert Lee, in his work on midwifery, has expressed an opinion that the apertures observed on the two opposed surfaces of the decidua are really open-mouthed blood-vessels communicating with the decidual chamber. He further supposes that blood is poured into the decidual cavity from the apertures in the ovular decidua, and that, after bathing the ovum externally, it is returned to the mother's circulation by the openings scattered over the surface of the decidua uteri. Thus, according to Dr Lee, the ovum

is provided in the early weeks of gestation with a peculiar circulation—the decidual chamber being a reservoir of blood—which continues until the cavity is obliterated by the development of the fœtus and its appendages. This view of the use of the decidual cavity has not, so far as I am aware, found any supporters; and it seems to me that there are two insuperable objections to its adoption. The first is, that the presence of blood in the cavity is generally acknowledged to be the result of accident or disease, and does not occur without some rupture or tearing of the tissues, a clear pinkish fluid being present normally; and the second is, that the lining of the tubes, regarded by Dr Lee as vessels, is not the delicate inner coat of a vessel, but is composed of well-marked cellules of glandular epithelium, such as lines the mucous follicles. The decidual vessels are no doubt in close relation to the glandular structures as in other situations, and may be made readily continuous by violence, but there is yet no evidence of direct and normal communication.

The function of the decidua ovuli appears to be confined to that of fixing the ovum at some safe anchorage in the uterine cavity, and of affording nourishment to the embryo by bringing its absorbent system into close contact with the maternal capillaries.

The decidua is loosened and thrown off from the uterus at the end of gestation. As pregnancy advances, it loses all the recognised characters of a mucous membrane; and, instead of being constituted, as at first, of a spongy web-like texture, it becomes

Fig. 7.

Mucous follicles filled with granular contents from the decidua uteri, near the placenta, in the third month. The clear flask-shaped space represents a duct from which the contents have been dragged out.

fibrous and thin. I have distinctly made out the uterine glands in the parietal decidua near the seat of the placenta, in the third month of pregnancy, just before the deciduæ came into apposition. They were undergoing a granular degeneration into fat, prior to their final disappearance; and, instead of being paved with the usual epithelium, they were filled with molecules and granules from the disintegration of cell-particles. Their contents were sometimes squeezed out by manipulation, and the emptied follicle then appeared as a clear excavation in the parenchyma of the membrane. The temporary structures of intra-uterine growth during gestation, when they have fulfilled their function, obey the same laws as other soft tissues in the body—they atrophy and disappear, undergoing first a molecular transformation into oil globules, by which they are rendered more amenable to absorption and removal. Fatty molecules enter into the composition of the early and healthy decidua, and seem to serve the purposes of nutrition; but in the later months of pregnancy, not only do the cellular and fibro-cellular elements, apart from the placenta, undergo molecular transformations into fat, and become freely mixed with compound granule cells, but the vessels themselves, which supply the membranes with blood, become ætheromatous, and their coats thickly studded with oil globules. Dr Simpson suggests that it is by this process the decidua gradually loses its cohesion to the uterus, and at the full time entirely separates itself, thus determining the occurrence of labour. From this he deduces an analogy between the spontaneous shedding of the decidua, and the artificial process of separating the membranes to which we have recourse in inducing premature labour. I shall have to shew you, in a future lecture, that this spontaneous separation is in close connection with the development of a new mucous membrane, which takes the place of the exfoliated decidua after delivery.

The decidua, being composed of so lax a tissue, and being so freely supplied with blood-vessels, is particularly liable, during the early part of pregnancy, to effusions of blood into its parenchymatous substance, which may be determined by accident or disease. Notwithstanding the uterus is so suspended in the maternal pelvis that it is affected in the least possible degree by ordinary locomotion, and by the various changes in the position of the body, yet the union between the pregnant uterus and its lining membrane is so unstable in some women that a fall, or leap, or a stumble, may be quite sufficient to detach a portion of the latter, and give rise to

sanguineous extravasation. Small and circumscribed clots produced in this way are sometimes found between the uterus and decidua. These, if limited, may not interrupt the continuance of pregnancy, but if the effusion be more extensive, and separates a larger portion of the decidua, it necessarily interferes with the nutrition of the ovum, produces death of the fœtus, and precipitates abortion. Again, if the escape of blood from the vessels is confined to a limited space at the upper part of the uterus, although it may produce much pain, no external hæmorrhage may be noticed at the time of its occurrence; but when it takes place near the cervix, the blood more readily finds exit from the uterus, and is discharged by the vagina. In aborted ova you may frequently observe blood-clots, which have been formed at different times, undergoing various changes in consistence and colour, according to the date of their effusion. Some have a deep purple colour, some a chocolate-brown, others a yellow hue. Generally, the recently expelled ovum, if enveloped in the decidua, is covered over with thick layers of fibrine, which need to be removed from the dorsal surface of the latter before its proper texture can be discerned. Even then the tissues may be so condensed and injured by the pressure to which they were exposed during expulsion, that they may not be readily recognisable, and may need maceration in water for some time before they can be examined with advantage.

Occasionally in the first weeks blood pours directly into the decidual cavity, fills it with a coagulum, and obliterates all trace of the embryo, constituting one of the species of mole, which is thrown off as a triangular cast from the uterus, and has firm layers of fibrine externally, with a soft clot in the centre. A not uncommon appearance is that in which the cavity and both layers of decidua are infiltrated with blood, become firm by coagulation, and nodular concretions project under the chorion towards the chamber which contains the fœtus. This form is designated by some authors the apoplectic ovum. It is a modification of the same morbid change which produces the other varieties I have described, and caused by the extravasation and hardening of the maternal blood in the substance of the decidua. An embryo is sometimes found attached by its funis to some part of a smooth central cavity; but many times it is absent, a rudimentary umbilicus being the only trace of its previous existence.

In early abortions the decidua uteri is usually detached, not only from the uterus, but from the ovum itself, and is expelled

separately, the embryo being wrapped in the ovular decidua, or being contained only in its own chorion. The serotina or placental portion of the decidua is seldom separated until a later period, and comes away as debris in the lochia. The decidua is also said to be subject to inflammation and its results—exudation of lymph, and the formation of pus. Some authors mention calcareous deposits and spicula of bone as occasionally found in its substance. It also contains, in some cases, a much larger quantity of fat granules than the normal proportion; but what relation this bears to changes taking place, in previously extravasated blood or exuded lymph, is not determined. This department of pathology offers a field as yet little explored, and which would well repay a careful investigation. It is well known that some women abort regularly at the same period of pregnancy, and that all treatment is ineffectual to break what is called the habit when once acquired. It is most probably connected, in many cases, with some abnormal condition of the blood or vessels of the mother, which exhibits itself in changes in the maternal envelopes of the ovum; and we cannot hope to be more successful in treatment until we have a more intimate knowledge of all the circumstances, and learn what these changes really are.

LECTURE III.

The Development, Structure, and morbid Anatomy of the Chorion and Amnion.

THE *chorion* is the outer of two membranes which envelop the ovum, and which are called fœtal membranes proper, in contradistinction to the deciduæ, which have an uterine origin. The former are developments from the surface of the ovum itself, and are believed never to be present in the womb unless an ovum has been successfully impregnated, and has undergone some of the progressive stages of growth towards the perfection of a new individual. The chorion is thus the middle tunic between the fœtus and uterine walls, the deciduæ (taken as one) being external, the amnion lying on a plane internal to it. It is a single membrane, and a perfectly closed sac. Its inner aspect is smooth, like a serous membrane; its outer surface has a shaggy, tomentous appearance, from the projections everywhere over its circumference of filamentous processes, termed villi (see fig. 5, *d*). During the first week of pregnancy, while the ovulum remains in the Fallopian tube, it undergoes some internal changes, and also becomes coated with a layer of albumen; but it preserves as yet the character of a small cellular body, with a comparatively smooth external outline. In the youngest embryos, however, which have been detected in the uterus, the external surface has been observed to be studded over with little cellular projections, the first rudiments of the villi, which take their origin in the delicate investing membrane or chorion, the latter being separated from the embryo by a slight interval. These cellular projections—simple and undivided at first—increase in number and growth, become compound by throwing out branches, and thus give rise to the usual shaggy appearance of this membrane. In the majority of cases of abortion during the early weeks of gestation, the ovum is extruded, wrapped in the chorion as its external envelope, which is recognised by its villous tomentum; the deciduæ being ruptured and left behind in the uterine cavity, to be expelled afterwards. According to Bischoff and Martin Barry, the villous

processes first shew themselves on the ovum either before it quits the Fallopian tube, or immediately afterwards when it has entered the uterus. They are developed from the zona pellucida or clear ring which, as we saw, surrounds it externally, in conjunction, probably, with the deposit on its surface, acquired in its transit through the tube. Be this as it may, in the second or third weeks after impregnation, it has been seen enveloped in a villous chorion, and lying loose in the cavity formed by the ovular decidua. Shortly after this period, the villi, having undergone increased growth, become attached to the wall of the ovular chamber, and pushing themselves into the substance of the decidua, acquire such firm adhesions to it, that separation without tearing soon becomes almost impossible. The chorion is said to consist of two laminæ—an external, the *exo-chorion;* and an internal, the *endo-chorion.* The chorion is not, however, a double membrane in the same sense as the decidua; but when first formed is simply a closed sac, the walls of which are thin and transparent, and consist of nucleated cellules, united together by their edges, as in epithelial membranes. As development advances, little hollow projections like the fingers of a glove —the rudimentary villi—are raised up on its outer surface, the hollows looking towards the chorial cavity. Up to this time the membrane is destitute of vessels; but soon a little bag or vesicle, which has been gradually approaching from the embryo, comes into contact with it, and spreads itself over its inner surface. This vesicle is called the Allantois. It arises as a small sacular expansion upon which the umbilical vessels ramify, from the caudal extremity of the embryo; and, extending itself until it encounters the chorion, it unites with it, and becomes its vascular layer or *endo-chorion.* Capillary loops are then given off from this vascular layer, and enter the hollow villi. They follow the development of the latter, occupy a central situation in their trunks, and penetrate as far as their distal extremities, forming an integral and inseparable part of their structure at a subsequent period. When union with the allantois has taken place, the villi take on a rapid growth, small cellular buds present themselves on various parts of the yet undivided trunks; and these, developing themselves into irregular and tortuous branches, and the branches again in the same way reproducing branchlets, compound processes of great complexity are formed, which interlace and ramify in the substance of the decidua, in so intricate a manner, that a complete net-work is the result, ultimately

defying all attempts to unravel its meshes, or to trace any given process to its original parent trunk.

In the early weeks of gestation the villi are planted pretty closely and uniformly over the external surface of the chorion. A little later many of those which are in contact with and are imbedded in the ovular decidua, and are thus separated from the uterine wall by the space of the decidual cavity, atrophy and disappear. In the third month of pregnancy, a limited number only of villus trunks, with intervals between them, arise from the chorion at this situation, and these remind one of stunted shrubs planted here and there over a patch of ground which shortly before had a luxuriant vegetation. As the ovular chamber expands with the growth of the ovum, and its walls become thinner, the villus trunks become still more widely separated and atrophied, and in later months a few only remain to unite the chorion and deciduæ together, which seem like fibrous threads passing between their opposed surfaces. They are often represented as disappearing entirely from every portion of the chorion, except at the situation of the placenta ; but I have nearly always found them present in a shrunk and atrophied condition, away from the placental spot, even at the completion of gestation, when I made a careful search for them in the secundines. Both Professor Müller and Dr Druitt mention the fact of their permanence to the full period of pregnancy. A great number of the villi present in early gestation, nevertheless, fulfil only a temporary function. As soon as the placenta is formed, this function is in a great measure superseded, and *pari-passu* with the gradual disappearance of the capillary net-work in the decidua ovuli, the villi in contact with it being deprived of nourishment, undergo fatty degeneration, atrophy, and thus partly disappear, a few only remaining until the end of pregnancy.

That portion of the shaggy chorion, on the contrary, which is in contact with the decidua serotina, and is thus brought close to the uterine wall, undergoes a marked and progressive development to form the placenta. The villi become concentrated, as it were, on the spot, and ramify and penetrate in all directions like the roots of a tree. They constitute at length a large portion of the placenta or after-birth ; and containing the fœtal blood-vessels, bring the fluids of the fœtus into close relation with the mother's circulation, for the purpose of effecting the double function of nutrition and respiration for the embryo.

Although I have described the villi of the chorion in the early stages as hollow cellular processes springing from the surface of the membrane, to which they are appendages, I must not omit to mention, that as growth proceeds, and each little offshoot becomes developed into a great tree villus with spreading branches, the trunk becomes solid, and, losing its cellular structure, assumes the fibrous form, by which it attains greater firmness and stability, and the fœtal vessels then occupy a central position in the interior. The ultimate terminations, which have a club-shaped form, retain the cellular character, and little buds, composed of nucleated particles, spring up as nodules on their surface, and thus provide for a constant succession of new branches. Over both trunks and terminal offshoots, is spread a thin membranous covering of cellular structure, which seems like an outer envelope, and is supposed by Mr Goodsir and Schroeder van der Kolk to be derived from the decidua. This cellular layer is readily seen in the newly formed placenta: and in breaking across the trunk of a villus, it is frequently retracted from the fibrous structure beneath, and appears

Fig. 8.

Villi of the chorion in the second month, shewing their irregular and contorted form, and the cellular buds for new branches. *a*, the external cellular sheath which has been accidentally denuded from *b*, the stem of a villus having a central fibrous structure. *c*, cellular buds for new villi.

as a corrugated outer coat. Even at the full time, when this membrane is firmly adherent around the villi—if a placenta has

been macerated for a day or two in water—it may be separated as a cellular sheath, both from the trunks and extremities of the tufts. It forms, as we shall see afterwards, a part of the maternal portion of the placenta.

The chorion is subject to certain morbid alterations, with which it is of importance you should make yourselves acquainted. Some of these may be left until we come to the morbid anatomy of the placenta; but there is one singular transformation, which seems peculiar to the early months, and which needs some description here. The pathological change I allude to is one in which the villi undergo a transformation into vesicles or cysts, varying from the size of a millet seed to that of a grape, and these are intimately united together at various points by thin stems or pedicles. When the chorion has undergone this alteration by disease, repeated discharges of blood and water take place at intervals from the vagina, and at length the patient experiences all the symptoms of miscarriage, and expels a mass from the uterus either entire or in separate portions. The substance expelled has in some cases the appearance of a fleshy cast of the interior of the womb, cysts being imbedded in its substance; in others, it bears some resemblance to a bunch of grapes, an immense number of little bladders being strung together in clusters, and united in a plexiform arrangement. These two forms are known to obstetricians under the appellation of the vesicular or hydatid mole, the one being simply a more exaggerated form than the other of the same morbid condition. The most ridiculous mistakes have been made as to the nature of these vesicular bodies thus expelled from the uterus, and it is probable that some of the alleged instances, where an incredible number of supposed ova have been extruded at one time, were cases of this description. In Pare's Surgery it is recounted 'that the Countess Margaret, daughter to Florent IV., Earl of Holland, and spouse to Count Herman of Heneberg, on Good-Friday, in the year of our Lord 1276, and of her age 42, brought forth at one birth 365 infants; whereof 182 are said to have been males, as many females, and the odd one an hermaphrodite, who were all baptised, those by the name of John, these by that of Elizabeth, in two brazen dishes, by Don William, Suffragan Bishop of Treves.' It is added, 'the basins are still to be seen in the village of Losdun, where all strangers go (on purpose) from the Hague, being reckoned among the great curiosities of Holland.' Possibly these 365 infants, so authenticated, were nothing more than chorial

vesicles, such as I have described to you; but how the sex was determined I know not. Until very recently, they were supposed to be of the same nature as hydatids found occasionally in other organs. They are now known to have no affinity whatever to acephalocysts, but to be the effect simply of a peculiar disease attacking the chorion.

An excellent description of the different stages of this transformation, after Dr Mettenheimer, is to be found in Mr Paget's Lectures on Surgical Pathology, to which I would refer you; and Dr Barnes has also given a good account of it in the *Medico-Chir. Review*. Instances of hydatigenous chorion are not infrequently met with, but they are not of very common occurrence. I have myself met with about half-a-dozen cases in different stages of this malformation. In three, a large quantity of the round or oval vesicles of various dimensions were expelled in bunches, and unenveloped in any general covering, being united together at numerous points by bands or commissures, thus forming an elaborate net-work. The cysts were occasionally imbedded in a fleshy matrix, recognised as thickened decidua, and in which glandular tubules could sometimes be discovered. Detached fragments of decidua were also found here and there, lying loose among the vesicles. In the same specimen, all the different stages of morbid development could be traced from the healthy villus. Placing a terminal branch under the microscope, which seemed to the naked eye nearest to the normal condition, it was seen to be enveloped by a granular covering, probably derived from the altered decidua; the club-shaped extremities were observed to be distended with large nucleated cells of unequal growth, having very delicate walls, and bearing little resemblance to the small and more uniform cellules, composing a terminal villus in the healthy state. By compression the envelope bounding the villus could be ruptured, and gave egress to the cells. The cysts, fully developed, had two coats like a normal villus, the external epithelial, the internal delicately fibrous. An incision being made through these—if the preparation was fresh—what appeared to be a viscous or gelatinous fluid escaped from the aperture, and was found to be contained in large transparent cells, with walls of extreme tenuity, assuming the polyhedral form from the pressure to which they had been subject. The entire contents had much the appearance of the vitreous humour of the eye, which has transparent partitions running across, separating the fluid into compartments: the

presence of a nucleus, however, in each compartment, clearly proved it to consist of a largely developed thin-walled cell. In the largest cysts the pellucid cells were not readily discernible, having probably undergone solution. Scattered over the vesicles and their connecting peduncles were little nodular projections, consisting of cellular buds for new branches, such as exist in healthy villi. The narrow stems uniting the cysts were fibrous, with a cellular covering, and sometimes enclosed a small vessel full of blood. Fat granules were copiously deposited in the texture of both stems and vesicles.

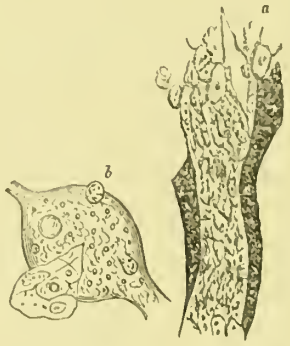

Fig. 9.

a, Extremity of a villus of the chorion in an early stage of cystic degeneration, the bounding membrane being ruptured, gives egress to the dropsical cells. *b*, A small but fully developed cyst, attached some distance below to the trunk of the same villus, and also to other cysts; rudimentary vesicles project from its outer surface, and pellucid gelatinous-looking cells are escaping from a rent in its envelopes. The delineation of the escaping cells gives no notion of their extreme tenuity. (Mag. 190 diam.)

Pathologists, therefore, who have noticed the progressive changes I have described to you, conclude that the uterine vesicles take their origin in an abnormal development of the cells which, under ordinary circumstances, fill the extremities of the chorial villi; that when a cyst is once formed it elongates and thins the stem which becomes its pedicle, and that branching going on in the ordinary way, a constant succession of cysts is produced, by which the uterus is at last so distended that it contracts and expels them. It is probable that in most cases an embryo perishes at a very early period, its chorion vegetating independently afterwards, and taking on the cystic formation. A blighted embryo is sometimes found in the centre of the mole, but generally no trace of it is

discoverable. I shew you a specimen supposed to be about the second month of gestation ; the embryo is present, is small in proportion to its envelopes, and seems in a blighted condition. A number of small cysts are in process of formation on the trunks of the villi, which are attached to the chorion. It represents one of the preliminary stages of this disease. I believe the cystic formation always attacks the chorion first in the early weeks of gestation, before the formation of the placenta, and I am not aware that any placenta, when fully formed, has been found to be the seat of considerable sized vesicles, such as those I have described.*

In your future practice you may be called upon for a reply to the query, Can the vesicular or hydatigenous chorion ever occur in woman, except as the result of conception ? The problem may seem to you not difficult of solution. You have been taught that the vesicles are parts of the degenerated chorion ; that the chorion is an appendage of the fœtus, developed from the surface of the ovulum, and specially a part of its tissues ; further, so far as we know, no fœtus can be developed in the womb except as the result of impregnation. And yet an opinion is still held by some authorities, that this abnormal condition may arise without sexual congress having previously occurred. Very recently I became acquainted with a case in which a medical attendant was censured for having impugned the character of an unmarried lady, by stating that vesicles such as I have described, and which had escaped from the vagina, could not have existed except as the result of improper intercourse. To strengthen his position, the medical attendant sought the opinions of most of the leading obstetricians in this country, and the result was that, although the balance of evidence greatly preponderated in favour of the opinion he had expressed, yet there was at least one notable dissentient, who believed the vesicular mole might be formed in the virgin uterus. Moreover, it is possible, as mentioned by Dr Montgomery, that a portion of the chorion of a previously aborted ovum may be left in the uterus, and that this growing and undergoing cystic transformation, may distend the uterus with vesicles, which at last

* Through the kindness of Dr M'Clintock of Dublin, I have lately seen a preparation mentioned by Dr Montgomery in his 'Signs of Pregnancy,' in which a mass of cysts, formed by degeneration of the chorion, was enclosed in two layers of decidua—the decidua vera and decidua ovuli. A cavity existed between the two membranes, and the cysts adhered intimately to the inner surface of the decidua ovuli. No embryo was discovered in this case, but a large corpus luteum was present in one of the ovaries.—(*Sept.* 1859.)

make their escape thence. If, under such circumstances, the husband of the patient had been absent since the previous miscarriage, unjust suspicions of her chastity might be entertained, unless a possible connection with the previous abortion were recollected and admitted. My own conviction is, that the cystic chorion cannot be formed except as the result of impregnation, but so long as observers differ on the question, it cannot be regarded as finally decided.

The *Amnion* is the innermost fœtal membrane, and lies next the fœtus. It is present and closely surrounds the embryo at a very early period of development. Wagner represents an ovum where the embryo is not more than two lines long, and where the amnion is plainly visible. It is a delicate and transparent, but tough membrane, which is continuous with the common integument of the fœtus at the umbilicus, and is supposed to be developed from the same layer of germinal membrane as the skin, namely, the serous layer. As seen in the drawing copied from M. Coste (fig. 10), where the pregnancy dated from twenty-five to twenty-

Fig. 10.

An embryo of about twenty-five days divested of its deciduæ, and the chorion thrown open. *a*, The shaggy chorion opened, and pinned backwards. *b*, The newly formed amnion closely surrounding the embryo *f*. *c*, The cavity of the chorion. *d*, The umbilical vesicle. *e*, The pedicle of the allantois uniting the embryo to the chorion. (After Coste.)

eight days, it appears separated by a slight interval from the fœtus, something after the fashion of the layer of epidermis raised by a blister; and a wide space exists between it and the chorion. By and by the separation between the embryo and amnion widens, the latter assumes more distinctly the form of a containing envelope, and a fluid called the liquor amnii, which is secreted on its inner surface, increases progressively in quantity, distending it outwards, until at length the membrane comes in contact with the chorion, and applies itself in close apposition. The two membranes, after

this, develop eccentrically together, and equally increase their capacity during the further progress of gestation. The mode of growth, indeed, resembles the eccentric development noticed in decidua ovuli, all the membranes being like a series of distinct and separate cells enclosed one within another, in their early formation, but being pushed outwards by the increasing size of the containing fœtus, until they become closely applied to each other and form one sac.

In the first and second months of pregnancy, when the amnion and chorion are separated from each other, the intervening space is occupied by a gelatinous fluid, which is traversed by delicate transparent filaments, and has been designated by M. Velpeau the 'corps reticulé.' This celebrated embryologist regards the 'corps reticulé' as the contents of the allantoid sac, which I have previously mentioned as springing up from the embryo, to unite it with the chorion. Müller and other observers, however, consider M Velpeau's statement not confirmed in the human subject, and regard the allantois, and another sacular process adjacent to it, called the umbilical vesicle, as imbedded in the 'corps reticulé,' which is simply an albuminous secretion around them, filling up the interval between the two fœtal membranes proper. Be this as it may, a fluid is sometimes contained in this intervening space, external to the amnion, until the latter months of pregnancy, and constitutes a false amniotic fluid, which, being discharged during the early stage of labour, may give rise to an impression that the waters immediately surrounding the fœtus have escaped, when in reality the true amniotic sac is unruptured.

You will have gathered from what I have just said, that besides the 'corps reticulé,' two vesicles, the allantois and the umbilical vesicle, are situated between the chorion and amnion in the early weeks of gestation. These are temporary structures, which I shall describe more fully presently; but I may remark in passing, that their pedicles enter into the structure of the umbilical cord, and the amnion, in giving a covering to the cord, is reflected over them from the umbilicus of the fœtus, thus enclosing them in a sheath: the amnion passes then to the fœtal surface of the placenta, becomes firmly united to that organ; and, lastly, is continued over the inner surface of that portion of the chorion which does not take part in the formation of the placenta.

The amnion is perfectly smooth like the peritoneum on its inner

surface, and is bathed by the waters which surround the fœtus. Histologically, it is composed of flattened epithelial cells of an oval shape, and containing a well-marked nucleus. These rest on a delicate fibrous structure, to which the amnion owes its tenacity, and by which it is united to the chorion. No vessels have been seen in its substance.

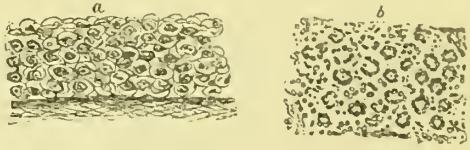

Fig. 11.

a, Epithelial cells resting on a delicately fibrous structure from the amnion at the eighth month. *b*, Minute rings of fat granules surrounding the nuclei at the term of gestation. The arrangement of the focus prevents the outline of the cells being seen. (Mag. 190 diam.

At fig. 11, *a*, I have represented the microscopic structure as it appears in the eighth month of pregnancy. Its cells undergo little change in form with the growth of the membrane, and they are probably concerned in the secretion of the fluid which fills the amniotic cavity, and in which the fœtus swims freely. The fluid contained in the amnion, and called the *liquor amnii*, constitutes what is called 'the waters' of the gravid uterus, and is discharged with a gush, or dribbles away slowly, when the membranes are ruptured at the time of delivery. Consisting of scarcely more than a few drops when the amnion first shews itself raised above the surface of the embryo, towards the full period of gestation, it averages nearly a pound in weight. It varies much in quantity at the different stages of development and in different pregnant uteri. In the early months it preponderates relatively to the weight of the fœtus; at the middle of gestation the fœtus and fluid are very nearly equal; at the full time the fœtus is four or five times as heavy as the liquor amnii which surrounds it. In some pregnancies, however, it reaches the weight of several pounds, and is then accounted one of the causes of lingering labour, acting by distending the uterus and preventing its proper contraction. At first the liquid is clear and limpid, scarcely of greater density than pure water. Later it acquires a slight increase of specific gravity, and becomes more viscid and apparently greasy, from fat globules and epithelial débris floating about in it. It has usually a faintish

smell, and may be tinged yellow by the meconium or contents of the fœtal bowels. It may be turbid, or even fœtid, if the fœtus has been long retained in the uterus after its death. In chemical composition at the full time, it consists principally of water, with traces of albumen, hydrochlorate of soda, phosphate of lime, and lime.

The source of the liquor amnii has been much debated; one set of authors asserting that it comes from the mother, others averring that the source is the fœtus, and a third holding that it is produced by mother and fœtus conjointly. Burns supposed it to be poured out on the inner surface of the amnion by pellucid vessels which were invisible; while M. Velpeau believes it to be the effect of simple transudation, as fluid is exhaled in the pericardium and elsewhere. I think there is reason to suspect, however, that the epithelial particles which line the amniotic sac, and which have all the characters of secreting cells, are the real agents engaged in the production of this fluid. In all probability, the superficial layer of cells having become distended with fluid in virtue of the property of absorbing, which we know like structures to possess elsewhere, burst and pour their contents into the amniotic cavity. When further secretion is no longer needed, towards the end of pregnancy, fat granules begin to occupy the cellules, and are readily discernible at the full time, grouped in minute rings round the nucleus, and obscuring its outline. (See fig. 11, *b*.)

The liquor amnii, in the early weeks at least, is supposed to contribute to the nutrition of the fœtus; and this because it contains more nutritious matters in the first than in the later periods of gestation. Its more obvious uses are to insulate the fœtus from the surrounding structures; to allow freely its necessary reflex movements of intra-uterine life, which without the fluid would be greatly impeded by the close apposition of the uterine walls; to protect the fœtus from external violence, and to permit it to alter its position with the varying attitudes of the parent. It also assists to keep the uterus uniformly distended; supports the placenta against the uterine walls; and by removing all pressure from the umbilical cord, it insures the proper continuance of the fœtal circulation. During labour the liquor amnii enclosed in the membranes forms a fluid wedge, which assists in the dilatation of the maternal passages; in escaping, it afterwards lubricates them. If

manipulations are needed, as in turning, these are greatly facilitated if the waters have not escaped.

The amnion is said occasionally to be the seat of inflammation, with results similar to those produced in serous membranes generally. The morbid changes are, however, so far as we know them, unimportant, and are not likely to be influenced by any treatment.

LECTURE IV.

The Allantoid and Umbilical Vesicles, and the Structure of the Placenta.

THE two vesicles which are contained in the space existing in early pregnancy between the chorion and the amnion, are the allantoid and umbilical vesicles.

The *allantoid vesicle*, or *allantois*, is a little pyriform sac, which springs from the lower part of the intestine of the embryo—before a division takes place in that canal to form the bladder—and extending itself rapidly, reaches the chorion, and spreads itself over the inner surface to form the endo-chorion. It carries with it, in its growth upwards, the umbilical arteries and veins which spring from the iliacs of the embryo, and when the allantois has reached the chorion, distribute their terminal branches in those villi, which enter into the formation of the fœtal portion of the placenta. In some animals the allantois is so large that it quite surrounds the amnion. In the human subject the sacular portion of the vesicle disappears very rapidly; according to M. Cazeau, scarcely a trace of it can possibly be found after the lapse of a few days from its first appearance, and its existence as a normal condition has thus been doubted by some authors. The pedicle remains somewhat longer, but cannot be traced through the umbilical cord at the end of gestation, although it is described as one of its component parts. In the body of the child, nevertheless, the fœtal end remains, and appears as a ligament, passing from the apex of the bladder, and losing itself in the navel-string. You have all doubtless recognised it, even in the adult, when dissecting the bladder; it is described as one of the ligaments of that organ, and designated the urachus. In fig. 10 you will observe at *c* the pedicle of the allantois of the natural size, containing the umbilical vessels, which are already in communication with the chorion. In fig. 12, however, a diagram

which is copied from M. Jacquemier, the relation of this vesicle to the fœtus and membranes will be more easily comprehended.

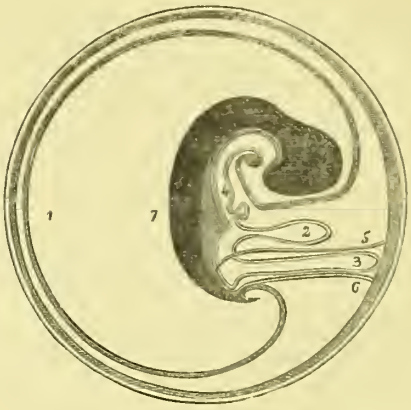

Fig. 12.

Diagram of the embryonic vesicles, from M. Jacquemier. 1. Cavity of amnion; 2. Umbilical vesicle; 3. Allantois bearing on each side, 5 and 6, the umbilical vessels to the chorion; 4. Ventral surface of embryo; 7. Its dorsal surface.

The *umbilical vesicle*, or, as it is sometimes called, the vesicula alba, is also contained in the interspace between the chorion and amnion. It is a much more distinct structure than the allantois, and retains its pouch-like form for a longer period. For this reason it has been more generally recognised and described by investigators in embryology than the allantois, although in the human species at least, it is apparently not so important in function as the latter. It was observed by Albinus, Wrisberg, and the Hunters, and the later researches of Müller, Wagner, Coste, Allen Thomson, &c., leave no doubt that it exists as a normal and constant appendage to the early embryo. The vesicle is largest during the first weeks of development, and communicates freely, by means of a wide duct, with the intestinal canal of the fœtus at the situation of the umbilicus. Observations made on the development of the chick, leave no doubt that it is identical with the yolk-bag, which is so prominent a structure in the egg of birds, and which furnishes a supply of nourishment for the formation and growth of the new being. The spheroidal human ovulum, when first lodged in the uterus, represents not inaptly a hen's egg; its external envelope, or zona pellucida, with the albuminous layers

it gathers in passing through the Fallopian tube, probably becomes developed, as we have already seen, into the chorion, and occupy the situation of the albumen, or white of the egg. Internal to this is the yolk mass, which by a process termed segmentation, divides and sub-divides until it consists of a multitude of small cells, which occupy principally the surface or circumference of the mass, and have received the name of blastoderm or germinal membrane. When the embryo first shews itself, it is as a ridge or elevation projecting from a portion of the surface of the yolk, and it has been ascertained that the part of the germinal membrane, out of which the embryo is formed, separates into two layers—the serous or external, from which are developed the skin, and the amnion ; and the mucous or internal, from which are formed the intestinal canal, and other organs of the mucous series. The embryo formed, therefore, in the layers of the germinal membrane, and, as it were, spread out upon the surface of the yolk mass, gradually acquires a boat-shape—the carina or keel uppermost—and folding inwards, constricts a portion of the yolk mass, by which a pedicle is formed, which unites the main body of the yolk with the interior of the embryo. In this way is formed the yolk-bag in birds, and the umbilical vesicle in mammals. The contents of the vesicle may be squeezed along the hollow pedicle or duct into the intestinal canal of the embryo, and back again, shewing the free communication between the two.

In birds the yolk-bag is gradually drawn in, and at last enclosed in the abdomen of the fœtus ; but in man it serves its purpose as a reservoir of nourishment to the early embryo, and afterwards dwindles away external to its body. At first lying close to the ventral surface of the embryo, with a constriction at the future umbilicus—the first indication of separation from the fœtal intestine—as the ventral opening contracts, a pedicle is formed and elongated, and the sac is further removed from the trunk of the embryo. An artery and vein passing out of the abdomen of the fœtus, enter the pedicle of the vesicle, and ramify on its sacular portion ; these are called the *omphalo-mesenteric* vessels. They of course disappear with the atrophy of the vesicle ; but I have seen them previous in a fœtus of the sixth month, as far as the middle of the umbilical cord.

The allantoid and umbilical vesicles, with the umbilical and omphalo-mesenteric vessels, are enumerated among the structures entering into the composition of the umbilical cord.

The *Placenta*, or *after-birth*, is a temporary intra-uterine organ, intended for the absorption of materials from the system of the mother, for the purposes of the fœtal economy; and also for performing an intra-uterine function analogous to respiration, by means of which the fœtal blood is purified from deleterious matters with which it becomes charged while circulating through the body of the embryo, and which retained, would necessarily produce its death. A new placenta is formed with each pregnancy, and together with the membranes, is designated the '*secundines*'—these being expelled subsequently to the child, at the time of delivery.

Serving like purposes wherever it exists, it nevertheless differs in form in different animals of the class mammalia, and likewise offers important modifications in its intimate structure. In the cow and other ruminants it consists of a number of separate flattened pieces, of a rounded form, called cotyledons, which are scattered here and there over the inner surface of the uterus. Each cotyledon consists of two lammæ—a fœtal and maternal layer—which admit of ready separation; the fœtal portion being formed of a number of finger-like processes, enclosing terminal loops of the umbilical vessels, which dovetail into corresponding depressions in the greatly thickened mucous membrane, constituting the maternal portion. In the mare the placenta is diffuse, or spread over the greater part of the interior of the uterus, the chorion being uniformly beset with vascular villi: in the cat again, and carnivora generally, it forms a zone or circular belt around the ovum. In the human subject it occupies only a portion of the interior of the uterus; it has usually a rounded or oval form, and is flattened like a cake against the uterine wall, to which it adheres by its outer surface. To the side which is opposed to this, and which is called the fœtal surface of the placenta, it is connected to the embryo by means of the umbilical cord. Taking the mature organ as our type, its diameter averages from seven to eight inches, and its weight from eighteen to twenty-four ounces. It is liable, however, to considerable variations both in size and weight, being generally largest with the heaviest children; but instances are recorded by Wrisberg and Stein, in which the placenta had undergone such an amount of hypertrophy, as to weigh in one case three pounds, and in another six pounds. On the other hand, the after-birth is sometimes much smaller in diameter than is usual at the full time, an increase in thickness counterbalancing for a diminution of the circumferential measurement; and it may be small from imperfect development, or

atrophied by disease. At its centre or thickest part it measures an inch or more in thickness, and gradually thinning towards the circumference, it is bounded by a comparatively sharp border, beyond which the membranes are prolonged upon the walls of the uterus. You will observe in a preparation before you, and also in one of the plates from William Hunter's 'Gravid Uterus,' that the placenta and membranes together form a large spheroidal bag, which contains the liquor amnii and fœtus, and that the placenta forms part of the containing sphere, the projecting portions of the fœtus appearing through the several membranes, which are closely applied to each other, and have now become diaphanous. During the progress of labour, the membranes generally rupture near the cervix or most depending portion, giving exit to the child; and are then left behind with the placenta, to be expelled in what is called the third stage of labour. Dr Simpson is in the habit of relating in his lectures an instance where a child was born with the membranes entire, the fœtus and secundines being expelled by a sudden effort, and the unusual phenomenon so alarming the practitioner in attendance, that the child was left to perish without any attempt being made to rupture the sac, and allow the access of air, which is necessary to its existence, immediately after separation of the placenta.

Although the membranes seem at first sight to be attached round the margin of the after-birth, they really clothe its fœtal aspect, and are reflected upon the cord at its placental insertion. The fœtal surface of the placenta is slightly concave; it is covered both by the chorion and amnion, the presence of the latter giving it a smooth and glistening appearance. At the insertion of the cord, which is usually near the centre, the umbilical vessels divide into a great number of branches, and may be seen radiating outwards in every direction. The uterine surface is slightly convex; is not so smooth as the fœtal surface, and is divided into a number of irregular lobes, with intervening sulci. These lobes are covered with a layer of laminated albuminous tissue, which in a recent placenta, expelled without much injury, passes across the sulci from one lobe to another, uniting them together; but it is so delicate in structure, that the bridges are readily broken down, and the lobes then appear separated from each other by deep fissures. This laminated layer, which seems like a plastic material, spread over the uterine surface of the placenta, adapting itself to all its projections and sinuosities, is none other than that portion of the altered mucous membrane upon which the villi

of the chorion were contentrated to form the placenta, and which, as I previously explained to you, has received the name of decidua serotina. In separating the placenta from the uterine wall, certain laminæ of this membrane remain attached to the inner surface of the womb; the rest are so intimately interwoven with the after-birth that they are carried away with it.

Making an incision through the thickness of the organ, the two surfaces are seen to enclose between them a spongy tissue; the section exhibiting minute granulations, traversed and united everywhere by fibrous-looking threads, and interspersed with irregular cellular spaces, in which the mother's blood circulates. On placing the preparation under water, the granulations are seen to be somewhat loosely disposed in the substance of the organ, and float out as tufts of short feather-like processes, which are attached to central stems.

Recollecting what has been said previously concerning the development of the villi of the chorion into the decidua at the placental site, it will readily be understood that a fully-formed placenta consists of a *fœtal* portion constituted by the ramifications of the villi of the chorion, and of a *maternal* portion formed by the uterine mucous membrane, modified and changed still further than when we studied it in the earlier months of pregnancy. The granulations which I have just described are in truth tufts of villi belonging to the original chorion, which have undergone little change in thickness, but have increased so much in number and length as to form the great bulk of the after-birth. The fœtal and maternal parts of the placenta are now so intimately and inseparably united to form one organ, that they are disjointed from the uterus together, and are expelled as one mass at the time of delivery.

I. The *fœtal* portion consists of the terminal ramifications of the umbilical vessels, enclosed in sheaths derived from the chorion, forming together the villi of the placenta. The umbilical vessels, two arteries, and one vein, which proceed from the body of the fœtus, pass through the funis umbilicalis undivided, and as soon as they reach the placenta give off radiating branches in every direction. The primary divisions of the arteries anastomose freely together, and again dividing and subdividing constantly, form at last an immense number of minute capillary arches, with the concavities looking towards the fœtus, and each arch or loop is

enclosed in a terminal villus. Each arterial twig is accompanied by its corresponding vein, which follows it in all its ramifications, and ultimately becomes continuous with it at its peripheral extremity, forming thus the opposite side of the capillary arch. The arches or loops thus formed have been well compared to the branchlets of a camel's hair-pencil, each division being separately enclosed in a covering from the chorion to constitute a villus, and a number of these together being arranged in sets, forming tufts or bouquets, as they did previously in the chorion. The villi are now so tortuous and so united together in the organ of which they constitute so important an element, that their identity with those of the chorion is not at first readily apparent; but if a piece of placenta be macerated in water, and then teazed out by needles, the tree and branch arrangement previously noted at once becomes visible. Thus with the microscope, each villous tuft is seen to consist of stem and branches, and the terminal divisions appear as digitations

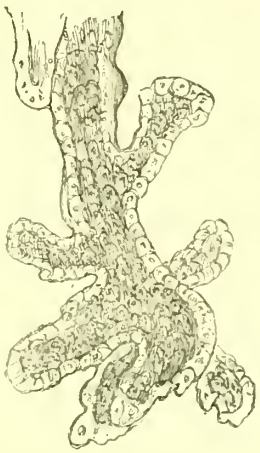

Fig. 13.

Drawing of a placental villus at the end of gestation: the mode in which the terminal digitations are given off from the stem is well seen, and also the double outline formed by a layer of epithelial cells seen in profile. The blood-vessels were emptied by pressure.

of a club-shaped form, through the transparent structure of which are discernible—if the placenta be fresh, and blood remains in the fœtal vessels—the contorted blood-vessels formed by the terminal loops of the umbilical arteries and veins, and which look like diminutive coils of intestine with crimson contents. The terminal

digitations of the villi are present throughout the entire thickness of the placenta, the club-shaped extremities, with their containing loops, being recognisable even close to the fœtal surface beneath the membranes, shewing that whatever function is performed in the organ, that function is as active in situations most remote from the uterus, as in those nearest to its walls. A layer of oval or polygonal cells, arranged in the form of an epithelial covering to the villi, and described by Mr Dalrymple, is readily apparent, and each villus, as it lies upon the object-glass, is seen to be bounded by a double outline, to the nature of which I shall have to direct your attention more fully presently. The child's blood, after being propelled from the fœtal heart through the umbilical arteries and their subdivisions, passes into the convoluted capillaries of the villi, is collected by the corresponding branches of the umbilical vein, and then returned back again to the right side of the fœtal heart through the vena cava.

That no direct communication exists between the fœtal and maternal circulations is now almost universally admitted, and you may prove it for yourselves in several ways. For instance, in managing a natural labour, as soon as a child has properly respired, we place two ligatures on the cord, and divide it between them. If after division you remove the ligature from that portion of the cord still attached to the placenta, the placenta being still adherent to the uterus, and open the vessels, you will not be able to procure more than a tablespoonful or two of blood, which has been contained in the terminal branches of the umbilical vessels;—none flows from the mother. Again, injected matters thrown into the umbilical arteries return by the vein, but do not escape from the uterine surface of the placenta unless tearing has occurred; and injections into the uterine vessels when the placenta is yet adherent, cannot be made to pass directly into the fœtal vessels. It has indeed been asserted as a further proof, that the blood-currents in the two do not commingle, that the blood-globules are larger in the fœtus than in the mother; but this must be a matter most difficult to determine.

The child's blood is indeed not only separated from the parent's circulation by the coats of its own vessels, but each terminal twig of the umbilical vessels is completely isolated from the maternal blood by the entire thickness of the sheath which surrounds it, and forms the parietes of the villus in which it is enclosed.

Although I have described the branches of umbilical arteries at their peripheral distribution, as being continuous with the umbilical

vein, by means of an intermediate system of looped capillaries, it is right to inform you that some difference of opinion has existed, and even now exists, as to the mode in which the ultimate divisions of the umbilical arteries become continuous with the umbilical veins. Dr John Reid, whose researches on this subject have deservedly received great attention, at one time held that each villus contained a terminal branch of both umbilical artery and vein, which inosculated together at their extremities, and were so closely bound together, as when uninjected to represent one cylinder. Professors Weber, Goodsir, and Mr Dalrymple, on the other hand, contend that small branches of the umbilical arteries end in capillaries, capable of carrying five or six blood-globules abreast, which make several convoluted loops in the extremity of a villus, before becoming continuous with vein; and later, Dr Reid himself acknowledged the accuracy of their description. In a remarkable essay on the 'Structure of the Placenta,' published in Holland by Dr Schroeder van der Kolk, and to which I shall have to make frequent allusion in connection with our present subject, I observe that the author states he has succeeded in injecting—in addition to the looped

Fig. 14.

An injected villus, bearing a number of terminal digitations, from a placenta at the third month of pregnancy, shewing a plexiform arrangement of minute vessels over the surface. (Magnified 90 diam. after Van der Kolk.)

capillaries—a much more minute set of vessels than has, I believe, been effected in this country, and the existence of which has

hitherto been unknown.* These form a delicate net-work over the surface of the villus, and have been observed by the author in some of the earlier and all the later months of pregnancy. This rete vasculosum, as he calls it, was injected from the umbilical vein, and was regarded as a plexus of veins. Professor Retzius, of Stockholm, has, we are told, successfully injected the same set of minute vessels. I have copied the drawing from Van der Kolk of this net-work on a villus (fig. 14), and if you compare it with the drawing I made from a terminal villus of a recent and fully-developed placenta, in which the vessels were full of blood (fig. 15), you will

Fig. 15.

One of the terminal digitations from the villus shewn in fig. 13; the microscopic focus was so arranged as to shew the convoluted capillary distended with blood in its interior. Magnified 190 diam.

see at once that not only are the vessels in the former more superficial and more delicate, but the arrangement itself is totally different, being in the one case a fine net-work, and in the other, one or more contorted capillary loops enclosed in the centre of the villus.

The terminal branches of the umbilical vessels, enclosed in the villi, are arranged in such a way as to be surrounded and bathed by the mother's blood, and the two currents mutually act upon each other without intermingling through the intervening textures. Whichever form be regarded as the true ultimate distribution, the extensive ramifications of the fœtal vessels in the placenta are evidently intended for increasing the area of surface by which the fœtal blood is to be exposed to the medium which purifies it, and supplies it with fresh nutrient materials, exactly as impure blood sent from the right side of the heart in an adult is spread out in minute capillaries over the surface of the air-cells, for efficient exposure to atmospheric air. There is no doubt, however, that the

* Since these lectures were delivered, Dr Arthur Farre has described what appears to be the same capillary net-work in the placental villi; but he regards this particular vascular arrangement as confined to the early months of pregnancy.—See *Cyclop. of Anat. and Physiol.*, article 'Uterus.'

placenta carries on the function of nutrition, as well as that of respiration, to the fœtus, during its sojourn in the uterus; and it appears to me not improbable, from the delineations, that the delicate net-work described by Schroeder van der Kolk, and injected from the vein, may be lymphatic or lacteal vessels engaged in the absorption of nutrient materials to be poured into the umbilical vein, as lymphatic vessels pour their contents into veins generally—the larger contorted loops with which we are most familiar being principally concerned in carrying on the respiratory process.

II. The *maternal* portion of the placenta consists essentially of cells or cavities, formed by dilatations of the mother's blood-vessels and of decidual structure. These cavities are present everywhere in the substance of the placenta, and in them the tufts of villi are suspended. Small curling arteries from the uterus pierce the layer of the decidua, covering its outer surface, and pour their contents into these cells among the ramifications of the villi; the maternal blood having performed its function, is re-collected and conveyed back again into the uterine veins, which are immensely enlarged and dilated in comparison with those of the unimpregnated womb. The investigation of the structure and physiology of this part of the organ is involved in great difficulties, and the exact relation the fœtal bears to the maternal circulation, has been the theme of the most animated discussions among embryologists. I have necessarily anticipated, in some measure, what I have to say on this subject; but to make you fully acquainted with all its details, it will be useful to give you a short sketch of the history out of which the theory was evolved concerning the double placental circulation, which is accepted in our own days. All shades of opinion have been held between the extremes that a direct vascular communication exists between the fœtus and mother, on the one hand, and that no maternal blood enters the placenta at all, on the other. The first hypothesis, which is the oldest, was supported by Noortwyk, Haller, &c., and has been revived in our own times by M. Flourens in France. Seiler, who, after Hunter, was one of the first to adduce satisfactory evidence that the decidua is really the transformed mucous membrane, believed that the maternal blood does not penetrate the substance of the placenta, the decidual layer on its uterine surface intervening between the circulation of the mother and that of the child. Seiler knew that injected matters

thrown into the uterine vessels, when the after-birth was adherent to its walls, were sometimes found afterwards in the placenta ; but he considered this the result of accident, and produced by violence. Other embryologists, among whom may be enumerated the celebrated M. Velpeau, still adhere to the same opinion. Dr Lee, in a paper published in the Philosophical Transactions for 1832, also defended this doctrine ; and, moreover, denied that the human placenta consists of two parts—a maternal and a fœtal portion : he remarked that, notwithstanding the large size of the uterine vessels at the placental spot, none could be seen to enter that organ even with the aid of a lens. Since writing that essay, Dr Lee has considerably modified the views there expressed, and he has adopted the belief that the maternal blood actually passes to the fœtal side of the decidual layer, and is poured into cells or interstices, which he aptly designates the cavernous structure of the placenta. Professor Owen, too, was at one time led to suppose that the maternal veins terminate on the decidua covering the outer surface of the placenta, because he was unable to trace them into its interior. He carefully dissected a gravid uterus under water from without inwards, at the situation of the placenta, and was able thus to trace the curling uterine arteries into the decidua ; but the veins seemed to terminate on the decidua by open mouths. In a second preparation, he was enabled to correct the result of the previous observation, and found that the uterine veins, or sinuses, as they are now called in their enlarged form, were continuous by direct channels into the substance of the placenta. Dr Adams, of Banchory, the erudite translator of Paulus Ægineta, has lately published a pamphlet, in which he adheres most pertinaciously to the notion that no maternal vessels pass through the decidua, and appeals not only to authorities, ancient and modern, in support of the doctrine, but seeks to strengthen his position by deductions from comparative anatomy. Those who are opposed to Dr Adams, and who support the doctrine of a maternal and fœtal portion in the human placenta, which are together thrown off at the time of delivery, do not, however, assert, as he seems to suppose, that the structure is entirely different from that which exists in the lower animals, but that a woman's placenta is simply a more complex modification of a like kind, and is really no more different than many other organs are, when compared in the different series of animals. Were we to admit the hypothesis of Dr Adams and others, we must be driven to the conclusion that the villi most

distant from the uterine wall, and which, under the microscope, may be seen as fully and perfectly developed close to the fœtal surface of the placenta, as they are at the maternal one, are either useless, or else carry on the processes of absorption and respiration, separated by the distance of nearly an inch from the uterine vessels, and consequently from the sources whence all nutritious and respiratory matters must be obtained.

That blood-vessels do penetrate the decidua, and pour their contents into the substance of the placenta, I believe now admits of no doubt; but do not suppose that because this is the case, any direct communication necessarily exists between the mother and child. Observe a recent after-birth, expelled without laceration: the vessels of the cord being tied, no blood can escape from the fœtal vessels. Yet blood gradually oozes from that face of the organ, which was applied to the uterine wall, until the placenta is surrounded by a pool of that fluid. This is maternal blood which was retained in the interstices of the placenta when it was separated from the uterus, and which now escapes from the orifices of divided vessels which were continuous before separation with the uterine veins. The uterine sinuses enter the placenta obliquely, and the extreme tenuity of their coats, where they encounter the decidua, renders them liable to give way on the slightest touch, whenever disseveration between uterus and placenta is attempted. For these reasons, investigations on the utero-placental circulation are very likely to be fallacious, even if conducted with the greatest care; and it is probable that the absence of proper conditions for examination in particular cases, has led observers into the error of supposing that maternal blood does not really circulate in the substance of the placenta.

To the brothers Hunter is mainly due the merit of discovering the way in which the double circulation is carried on in the human placenta. Some slight modifications have been admitted from time to time from their original description of anatomical relations in the placental mass, but the principle enunciated by them has received confirmation by most recent researches. The opinion of these celebrated observers was, that in the umbilical (or fœtal) portion of the placenta, the arteries terminate in the umbilical veins by a continuity of canal, whereas, in the uterine (or maternal) portion there are intermediate cells, in which the arteries terminate, and from which the veins begin. They concluded that the uterine arteries pierced the decidua; that the mother's blood was

conveyed into these cells or spaces between the ramifications of the umbilical vessels; and that, after having acted upon the child's blood through the coats of the latter, it was subsequently returned into the uterine veins or sinuses. The later researches of Owen, and the report of Messrs Stanley and Mayo on the preparations in the Hunterian Museum, all tended to confirm the correctness of these observations. Weber and Dr John Reid, while they concur in the general views of the Hunters, concerning the double circulation in the placenta, hold that the utero-placental vessels are prolonged beyond the layer of decidua lying on its surface, into the substance of the organ. According to the former, the delicate inner coat only of the maternal vessels penetrates the after-birth, and forms there a large vascular net-work, ramifying in the intervals of the placental tufts, and forming large sinuses into which the villi project, carrying the walls of the sinuses before them. Dr Reid describes the maternal placenta to consist of a large sac formed by the inner coat of the vascular system of the mother, which is intersected in many directions by the placental tufts, the latter projecting into it like fringes, and pushing its thin wall before them in the form of sheaths, which closely envelop both the trunk and each individual branch composing these tufts. Blood is brought by the maternal arteries to this sac, and returned from it without extravasation by the utero-placental veins. Dr Reid even saw fœtal tufts penetrating some of the sinuses situated in the uterine walls, and beyond the exact limits of the outer surface of the placenta. Mr Dalrymple subsequently denied the existence of any maternal cells in the placenta, and stated that simple spongy interspaces were present among the villi into which the mother's blood was projected. The researches of Eschricht and M. Bonami, detailed by M. Cazeau, led them to conclude that the maternal vessels pass through the decidua, and form in the substance of the placenta a net-work of exceedingly delicate meshes, which ramify and embrace everywhere the tufts of the umbilical vessels enclosed in the chorial villi. Schroeder van der Kolk, who had, during a cholera epidemic, excellent opportunities in Holland for making investigations on this subject, expresses his conviction that the decidua observed on the uterine surface of the placenta sends down into the substance of the organ dissepiments, which penetrate even to its fœtal surface, and circumscribe spaces, wherein the fœtal villi are suspended, and into which the maternal blood is poured from the uterine arteries, to pass thence into the uterine

veins. Neither maternal arteries nor veins are, he believes, prolonged into the substance of the placenta ; but the former, being numerous and small, terminate by open mouths in the decidual spaces—the blood, which is brought thither by the arteries, and returned again

Fig. 16.

A section through the pregnant uterus into the placenta at the sixth month, after Van der Kolk. *a*, Muscular tissue of the uterus in the midst of which appear wide apertures, which are the uterine sinuses. *b*, The layer of decidua intervening between uterus and placenta, and sending dissepiments down into the latter, represented by *c*, *c*. *d*, Tufts of villi lying in compartments formed by the decidual partitions. (Magnified 8 diam.)

to the veins, being fairly beyond the circulatory system of the mother so long as it occupies the interstices of the placenta. The

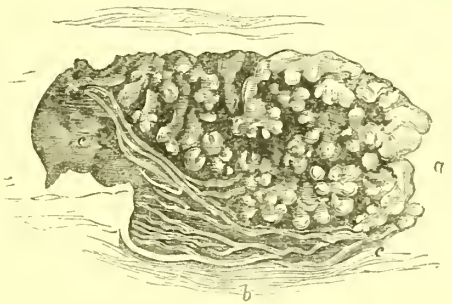

Fig. 17.

An excavation or cell in the substance of the placenta, viewed from within, and in which maternal blood circulates. *b* & *c*, The boundaries of the cavity. *a*, The villi suspended in the cell to be surrounded by the mother's blood. (Magnified 50 diam.; after Van der Kolk.

intra-placental cavities he describes as lined by an epithelial membrane, which is derived from the decidua, and is reflected upon the

villi, to cover and retain them in position. This layer is identical with that represented at fig. 13. The researches of this distinguished observer on the placenta have hitherto been little known in this country; his essay, being written in Dutch, is not generally available; but, I believe, the care and accuracy of his investigations, and the conclusions at which he arrived, will be universally appreciated by all who take the trouble to study his memoir. His lithographic drawings are clear and distinct, and, if faithful representations, prove beyond doubt the existence of a cavernous or cell-structure in the placenta. Fig. 17 is copied from his delineation of a hollow in the placenta, into which the villi are suspended to be bathed by the maternal blood; and he distinctly states that the villi are directly immersed in that fluid—no vascular coat, as described by Weber and Reid, intervening between them.

LECTURE V.

The Anatomy and Physiology of the Placenta.

In the last lecture, gentlemen, we passed in review the more important doctrines which have been held concerning the anatomy of the placenta. In most obstetric works you will find some differences of description, according as the views of one or other authority have been adopted; and I have thought it best to give you a condensed history of the various opinions, from time to time enunciated on this subject, in order that I might shew you where the differences really exist, and thus in some measure facilitate your study of this vital organ of intra-uterine life. To do this without confusing you is a difficult task; and I fear I have fulfilled it very imperfectly; but as a resumé, let me briefly point out to you what are the general principles deduced from these inquiries, and on what points there is a pretty general correspondence of opinion.

In the first place, we have the ultimate divisions of the umbilical vessels which have no communication with the parent's circulation, but are ensheathed in processes of the chorion, termed villi. These are either suspended in interspaces or cavities, or in the closest relation with capillary vessels containing maternal blood; they are thus bathed as it were by that fluid, and the fœtal capillaries are exposed to its purifying influence, very much after the fashion in which a fish aërates its blood by exposing its branchiæ to the action of the water in which it lives. The fœtal blood entering the placenta by the umbilical arteries, is charged with carbon, and incapable of supporting embryonic life; but it returns purified and oxygenated through the umbilical vein. That a change in the fœtal blood does take place in the placenta, which is analogous to that produced by the process of respiration, is certain;—for not only will the fœtus die if the placenta suffer injury by accident or

disease, but its circulation becomes speedily embarrassed, and its life endangered whenever the uterine contractions during labour are so violent and continuous that the mother's blood cannot pass readily through the uterine vessels into the placenta, to perfect those changes which are essential conditions of its existence. For this reason we deprecate, as a rule, giving ergot or other oxytoxics which produce violent and continued uterine contractions during labour, until the passages are fully prepared, and no delay is likely to occur to delivery.

But I have already told you that the respiratory is not the only function performed by the placenta. Besides this the fœtus needs the constant addition of new particles to carry on the process of growth, and to make up for the waste to which its tissues are subject in common with those of other organised bodies. Absorption of new materials must consequently continually go on, and this is effected also by the terminal villi, exactly as the spongioles of a plant absorb matters from the ground in which they are imbedded. Some of the villi in a mature placenta contain no vascular loops, and probably are endowed only with the function of imbibition. According, however, to a doctrine propounded by Professor Goodsir, one of the most philosophical of living anatomists, the same villi in which contorted capillaries are observed perform the double function of absorption and respiration. He describes a mature villus to consist first of an outer transparent membrane devoid of structure, and which he regards as the reflection of the internal coat of the mother's vessel, as described by Dr Reid. Under this is the layer of epithelial cells of a flattened spheroidal form, described by Mr Dalrymple, and represented at fig. 13 (Lecture IV.) These cells are believed to be derived originally from the decidua, and files of them pass off as threads from villus to villus, and from the villi to the sides of the placental cavities, each thread or bar being enclosed in a hollow sheath, derived from the vascular system of the mother, which is reflected over it in passing from one villous tuft to another. The extremities of the tufts exhibit, when magnified, a double outline, as though there were a double membrane with the epithelial cells between. 'At variable distances the space between the two outlines widens out into a triangular form—the base towards the external membrane, the apex towards the centre of the villus. The wider space is produced by a larger group of cells, which appear to be passing off in the centre of the mass. The groups of cells described are germinal spots, and they

are centres from which new cells are constantly passing off to supply the loss of those which have disappeared in the performance of their important functions.' More immediately bounding the fœtal blood-vessels is another transparent membrane, the *internal membrane* of the villus, and enclosed within this a number of very delicate cells filled with highly refractive matter, which immediately surround the vascular convolutions, and constitute the *internal cells* of the villus. The external membrane and outer layer of cells are readily detached from the villus, and belong to the maternal portion of the placenta; the internal membrane and inner layer of cells are fœtal, and are parts of the original villi of the chorion. A space frequently exists between the external layer of cells and the internal membrane, which contains a fluid matter, resulting from the solution of decidual cell-particles, or consists of their contents. The function, therefore, of the external cells, according to Mr Goodsir, is to separate from the blood of the mother the matters

Fig. 18.

The extremity of a placental villus after Goodsir. *a*, The external membrane of the villus, the lining membrane of the vascular system of the mother. *b*, The external cells of the villus, derived from the decidua. *c*, *c*, The germinal centres of the external cells. *d*, The space between the maternal and fœtal portions of the villus. *e*, The internal membrane of the villus. *f*, The internal cells. *g*, The loop of umbilical vessels.

destined for the nourishment of the fœtus, as the mucous membrane of the intestine in adult life selects materials from the ingesta, and the function of the internal or chorial cells is analogous to that of the absorbing chyle cells which are beneath the epithelium of the intestinal mucous membrane. Both series have probably some close relation to the minute capillary net-work described by Schroeder van der Kolk, whether this be regarded as belonging to the sanguiferous or lymphatic system.

I have little doubt in my own mind that Dr Reid and Mr Goodsir are right in representing the villi as everywhere covered externally by a reflection from the delicate coat of the maternal blood-vessels, and this, notwithstanding the assertion of the

distinguished Van der Kolk to the contrary. The evidence of this rests not only on the anatomical structure of the villi at the term of gestation, but is confirmed by observations made on the early development of the maternal vessels in the placenta.

During my residence in Edinburgh, my friend, Dr Sidey, brought to me a perfect ovum, in the second month of gestation, which had just been expelled from the uterus. It had evidently suffered little during its expulsion; the decidua uteri being almost entire, and bearing everywhere on its outer surface the glandular and vascular apertures peculiar to the membrane in a normal condition. The decidua ovuli nearly approached the decidua uteri, but there was yet a distinct intervening cavity. The placenta was in

Fig. 19.

A maternal vessel throwing vascular loops around villi of the chorion, from a young placenta in the second month. (Magnified 190 diam.)

progress of formation, and all the vessels were gorged with blood. In repeated sections through the circumference of the placental portion of the ovum I found the tufts of the chorion deeply rooted in the decidua, and around each separate villus was thrown a maternal vascular loop, formed of a capacious capillary, distended with fluid blood. Loop was connected with loop in such a way that a plexus was formed; the vessels thus enclosing spaces which were occupied each by a separate villus. I could trace the smaller branches back to larger trunks, and remarked that sometimes the

twigs given off on each side at once assumed the arched form, and could occasionally be detached from the villi, which they encircled, and shewn as distinct tubes. Other branches crossed at right angles to the villus trunks, and passed onwards to enclose the extremities of a more distant tuft. The villi had, as usual, a cellular external structure, and a clear space always intervened between the darker outline of the villus and the maternal vessel, which was occupied by a layer of transparent cells.

Fœtal capillaries were already present in the interior of the villi themselves, and could be seen here and there containing red blood ; they appeared at this time, however, as single loops formed of a straight tube bent upon itself, and possessed none of the convolutions visible at a later period. Although the celebrated Virchow has shewn that the maternal vessels undergo a rapid increase in size, I am not aware that any one has previously described this particular vascular arrangement in the young placenta. It is especially interesting, as it apparently forms a connecting-link

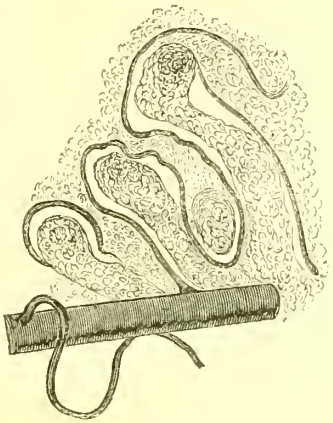

Fig. 20.

Another section of the young placenta from the same preparation as Fig. 19. (Through a mistake, this drawing has been reduced by the engraver more than the last, both being equally magnified.)

between the small vessels ramifying in the early decidua, and the large maternal sinuses which are present in the placenta at a later period. It suggests, also, an explanation of the way in which the sinuses are formed, and may account for their relation to the villi in a full-grown after-birth.

It is very doubtful whether at any time in very early pregnancy the tufts of the chorion are bathed directly by the mother's blood without the intervention of a vascular tunic, as some authors have supposed. It may rather be concluded that there are no patent-mouthed vessels opening into the ovular chamber of the decidua, but that in the earliest days the embryo is nourished by vital imbibition from the decidual cells, and that, as its wants increase, the tufts of the chorion root themselves into the decidua serotina, and simultaneously a maternal capillary loop is developed around each villus. Then, as growth progresses, and the chorial villi multiply, these maternal vessels, at first only small capillaries, so widen and dilate, that the digitations, as they are developed, become wrapped in the coats of what was once a simple looped vessel. From the pressure of development, the maternal vessels approximate to each other and coalesce, forming an inextricable net-work or vascular sac, into which the placental villi depend, and thus become covered by the maternal vascular tunic. The accompanying diagram (fig. 21) may assist you to comprehend what

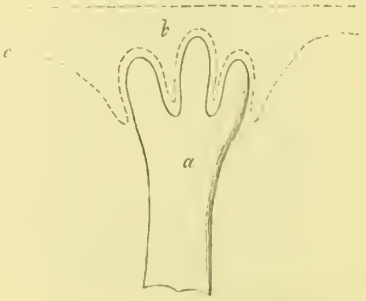

Fig. 21.

Diagram illustrating the mode in which a placental villus derives a covering from the vascular system of the mother—*a*, a villus having three terminal digitations projecting into *b*, cavity of mother's vessel; *c*, dotted line representing coat of vessel.

is otherwise somewhat difficult to understand—the way in which a placental tuft takes a reflection of the wall of the mother's vessel as one of its coverings. Suppose a villus trunk (*a*) with its terminal divisions placed against (*b*), a maternal vessel, which coincidently with the growth of the former is widening and increasing its calibre; as the villus elongates itself it pushes inwards one side of the vessel (*c*), becoming enveloped in its coat, and the vessel loses the form of a straight channel and becomes an

irregular vascular cavity or cell, a congeries of such cavities forming the cavernous structure or vascular sac of the maternal placenta.

In diseased and indurated placenta, you may frequently see the small curling arteries, in which the blood has firmly coagulated, broken off on the uterine surface of the decidua; these mostly enter the centre of each lobule, and making one spiral turn upon themselves, are lost in the structure of the placenta. When the organ is healthy, the coats of the arteries are so delicate that when emptied they collapse, and, with the greatest care, are scarcely discernible. The interlobular grooves, when uninjured, are really portions of vascular channels communicating freely with each other, and receiving smaller tributary canals from the substance of the placenta, which collect the blood to be returned to the mother's system; the former, before separation, are in contact with the inner surface of the uterus, and are continuous by delicate vascular walls with the large venous uterine sinuses. A large vessel of the same nature as the interlobular sinuses sometimes runs all round the circumference of the placenta, and has been called the circular sinus of Meckel; it communicates by branch-channels with the cavernous structure of the placenta, and also receives small tributaries from the membranes.

The great disparity in size observed between the arteries which carry blood into the placenta from the mother's circulation, and the veins which return it back again, suggests itself at once as a wise arrangement. The smaller calibre of the arteries and their numerous subdivisions minimises the force with which blood would otherwise be thrown into the delicate texture of the placenta; while the greater capacity of the utero-placental veins allows a steady and equable current in the intermediate sinuses, and perhaps also slackens the rapidity of the maternal circulation in the placenta, thereby giving time for that proper interchange of materials between offspring and parent, which is so necessary to the welfare of the former.

From what you have now learned you will be able to understand, that if the placenta be partially detached from the uterus, blood will still be poured into the organ by the arteries, supplying the portion not separated, and will escape from the torn sinuses of the portion detached—union with the uterine veins at this point having ceased to exist. In this way hæmorrhage ensues to the mother, and to the mother only. The child may suffer under such

circumstances exactly as an air-breathing infant would be affected by depriving it of the necessary conditions for respiration; but it cannot bleed, by a placental detachment from the uterus, nor indeed can it suffer from considerable hæmorrhage at all in connection with the after-birth, unless through rupture of one of the umbilical vessels, or of their larger branches, which is a most unlikely accident. Generally, the more the placenta becomes detached, up to a certain point, the greater will be the uterine hæmorrhage, and the greater the danger to the mother. When, however, only a small part of the after-birth remains adherent, the placenta has a proportionally diminished supply of blood from the uterus, and the hæmorrhage may be expected to be less; while it is pretty generally understood that when detachment is complete, hæmorrhage, as a rule, ceases—the vascular supply being entirely cut off. The knowledge of the fact that hæmorrhage is stayed when the placenta is completely detached, has suggested the proposal that, in certain perplexing and dangerous cases of placenta previa, we should attempt to save the life of the mother, by completely separating the placenta from its connection with the uterus before the birth of the child. Should the fœtus be living before the proceeding is resorted to, its life will certainly be sacrificed, unless immediate delivery be effected; and it is only had recourse to under such circumstances when great danger impends over the mother, and other modes of delivery are rendered difficult or impracticable.

But you may be ready to ask, Cannot bleeding take place directly from the mother's system, through uterine vessels which have been torn across in the separation of placenta? Occasionally this does happen; but it is the exception rather than the rule. Torn arteries generally do not bleed, the coats retracting and contracting, and coagula plugging up their orifices; and with respect to the veins, large as they are and liable to hæmorrhage, as we may suppose them to be, my good colleague, Mr Bloxam, has pointed out a mechanical arrangement of them in the uterine walls, which must greatly tend to obviate any such result. He found in the uterus of a woman who died thirty hours after delivery, large sinuses occupying the placental spot, which appeared as indentations in the uterine structure large enough to admit the little finger; at the bottom of these were the openings of other canals, elliptical in form, and penetrating obliquely downwards; a third series of openings still smaller in size appeared at the bottom of the last

mentioned; and it was specially remarked that no two openings of the series were on the same meridian. The tendency of such an anatomical disposition, combined with the contractile property of the parietes of the uterus, forms an admirable mechanism for the prevention of hæmorrhage. The muscular fibres of the gravid uterus being arranged in several planes, and acting in different directions, when thrown into proper contraction, effectually close the sinuses, and favour the formation of fibrinous plugs in their orifices.

No nerves have yet been demonstrated in the placenta, nor have we yet any conclusive evidence of the presence of lymphatics; the existence of both is highly probable, but it remains for future researches to decide the question.

The placenta is normally situated upon some portion of the upper segment of the interior of the uterus. The young ovum, when it first enters the uterus, rarely progresses far from the site it first occupies; the ovular chamber is thus formed usually near the fundus uteri, the placenta being developed at its base, and little change in the relative position of parts takes place in the further expansion of the uterus. In the majority of cases, therefore, at the full time, the placenta is found to be fixed to the anterior or posterior wall of the uterus not far from one or other Fallopian aperture. M. Stoltz has remarked a correspondence between the situation of the organ and the anterior aspect of the fœtus. According to Jacquemier, it is attached most commonly to the posterior wall inclining to the left side, and next in frequency to a corresponding portion of the anterior wall. Dr Montgomery, guided by hearing with the stethoscope a peculiar sound called the placental bruit, considers the most frequent site to be near the Fallopian tube of the right side. Occasionally it is situated directly over the fundus uteri, and, in certain cases, it becomes attached to the cervix, or is even planted over the os uteri itself. When any portion of it is placed over the os uteri, it gives rise to that formidable and often fatal complication known as placenta previa. The placenta thus becomes the presenting part, and as soon as the os uteri begins to dilate—often before labour actually commences, it begins to be loosened from its attachment, and hæmorrhage ensues. Every uterine contraction aggravates the mischief; for while it dilates the os uteri, it also tears away more of the after-birth from its attachment, and increases the amount of bleeding to an alarming extent. The hæmorrhage in these cases is therefore denominated

unavoidable, delivery being impossible without a partial or more general separation of the placenta and consequent loss of blood. Every such case occurring in practice is a source of the greatest anxiety to the medical attendant ; and you will understand that it is no slight complication to meet with—that it demands most careful study and all your resources—when it is computed that even under the most skilful management scarcely more than one in three mothers, who are the subjects of it, recover.

Obstetric auscultation will be more fully treated of under the head of Signs of Pregnancy ; but concerning the placental *bruit,* or *souffle,* as it is sometimes called, which I have alluded to in connection with the situation of the placenta, I may here inform you that in the gravid uterus, as early as the fourth month, a peculiar loud whizzing sound is heard with the stethoscope, which is synchronous with the mother's pulse, and has been compared to the blowing of a bellows. This increases in intensity as pregnancy further advances, and in the last months become more circumscribed and defined, reaching its maximum intensity at the situation of the placenta. Of course, if the placenta is situated on the posterior wall, it is not readily accessible to the stethoscope ; but in many cases the post-mortem examination has proved the correspondence between the placental spot, and the situation where the souffle has been detected during life ; and although exceptions are tolerably numerous where the sound is either so diffuse as to leave doubtful the centre of intensity, or in which this centre of intensity seems situated at two opposite points of the uterus ; yet as a general rule it may be affirmed, that where the souffle is loudest in a pregnant uterus, near that spot is the placental site. The cause of this peculiar sound has been much debated. M. Kergaradec, who first described it, supposed it to be produced by the circulation of the mother's blood through the placenta ; but several circumstances connected with the phenomenon seem to throw a doubt upon this ; and, without entering more fully into what must occupy us hereafter, I may briefly state that it is probably produced by the enlarged and tortuous uterine arteries, which converge towards the placental spot ; and which, becoming in some degree compressed by the eccentric development of the uterine contents, and by the resistance of the proper contractile coat of the uterus itself, through which they pass, produce this singular bellows murmur. It may be imitated pretty successfully by compressing a large artery in some part of the body with a stethoscope, and a

sound exactly similar is heard in large fibroid uterine tumours, where large vessels are imbedded in a dense fibrous structure, which, by a constant increase of fibres, impinges on the calibre of the artery and produces the characteristic sound. During labour it has been noticed to be more intense with the commencing pain, and to decrease when the uterine contraction is stronger and more general, seeming to prove that compression beyond a certain amount controls the vibrations which are the immediate cause of the sound—a powerful muscular contraction preventing in a great measure the circulation of blood through the ordinary channels.

The most singular anomalies in the site of placental insertion occur in cases of extra-uterine pregnancy. Thus, in instances of tubal pregnancy it has been found developed in the Fallopian tube; at other times it has been found in the peritoneal cavity attached to the broad ligament and ovary; to the intestine; and to the stomach and mesentery of the mother. Burns recounts an example where the fœtus was in the abdomen, and the placenta, notwithstanding, in the uterus; and, lastly, cases occur occasionally where the placenta is attached partly to the body of the fœtus, and partly to the uterine wall. The last form seems never to occur without some remarkable malformation of the fœtus, the adhesion of the placenta being apparently the cause of the monstrosity.

The shape of the placenta, though generally round, sometimes departs considerably from the usual form. Now and then it becomes elongated and oval, and some authors have represented it of such shape as seems more or less to approach the forms found in the lower animals. Cases have been noticed where the human placenta was spread over a large portion of the interior of the uterus, becoming thus diffuse like the placenta of the mare. Roedérer again, M. Cazeau, and M. Blot have described examples in which separate portions of placental substance were detached from the main mass, and formed detached lobules, thus representing a cotyledonous placenta, verging towards the form observed in ruminants. Lastly, the insertion of the cord upon the border of the placenta, gives rise to a somewhat common modification in its appearance, called the battledore placenta. When more than one fœtus is present in the uterus, a separate placenta, with its set of membranes, is generally provided for each, but these are in most cases united together by their edges, although in reality no vascular communication may exist between the two. Such an arrangement presents certain advantages, for if anything occurs which affects the

life of one of the twins, the other may remain entirely uninjured. More rarely in twin pregnancies the placentæ are quite distinct from each other, and are implanted at entirely different parts of the interior of the uterus; most rarely of all, one large placenta has been known to serve the purposes of two children without any mark of division in its structure.

Towards the end of pregnancy the after-birth generally begins to exhibit evidences of its temporary character, and of the approaching completion of its functions. Upon the outer surface of most recently expelled placentæ at the full time, may be found traces of fatty or calcareous degeneration. Frequently small white points are observed with the naked eye dotted over the surface of the layer of the decidua, clothing the uterine surface, and these being magnified, turn out to be minute portions of earthy matter, arranged in a stellate form. Occasionally the terminal vessels of the fœtus exhibit ætheromatous changes, and particles of fat are studded over the villi. These changes have been traced with much care by Dr Barnes and Dr Druit, and their relation shewn to morbid fatty degeneration of the placenta. It must be remembered, however, that the placenta as a respiratory organ at least, is as active in function up to the moment of delivery as at any previous period; that if the placental circulation is interrupted only for a short time, the child is likely to die of apnœa; and that any considerable alteration in its essential structures must act deleteriously. The changes evidencing its caducous character are indeed, so far as my experience goes, chiefly confined in placentæ born with stout and healthy children, to the decidual portion on its surface; and do not implicate as a rule the active and potential villi in the deeper substance of the organ.

LECTURE VI.

The Umbilical Cord.

THE *Umbilical Cord* or *Funis*, which may be regarded as an appendage of the placenta, is the means of connection between that organ and the fœtus. As its name expresses, it is a cord-like process attached by one end to the navel of the embryo, and by the other to the after-birth. Generally it is united to the centre of the placenta, like the stem of an umbrella, but frequent deviations from this arrangement are noticed; the most common being that in which the cord is joined to the edge of that organ, and which I have before described as the battledore placenta. The length of the cord at the termination of gestation varies considerably; Dr Churchill, who has written an excellent monograph on the umbilical cord, states that it averages from 18 to 24 inches. It has been known, however, to measure from 50 to 60 inches; and in Gardien's 'Traité des Accouchements,' it is mentioned that a M. Morlanne met with a case in which it reached the extraordinary length of five feet. On the other hand, it is occasionally preternaturally short, and has then been supposed by some obstetricians to be one of the causes of protracted labour, acting in direct opposition to the uterine expulsive efforts, and tying up, as it were, the fœtus to the fundus uteri, or wherever else the placenta may be situated. Mauriceau, Baudelocque, and others, have observed it six inches long, and Guillemeau under three inches.

No distinct funis exists during the first two or three weeks of embryonic life, the young fœtus lying close to the inner surface of the chorion. At the beginning of the second month, however, it appears as a very slender short cord, passing between the membranes and fœtus, and is then composed of a number of distinct parts. These consist, 1. Of a double sheath, derived respectively

from the chorion and amnion, each of the membranes affording a covering to the cord; this sheath envelops all the following structures:—2. The vitellary duct or pedicle of the umbilical vesicle, which communicates at its fœtal end with the intestine of the embryo. 3. The omphalo-mesenteric vessels ramifying upon the vitellary duct. 4. The obliterated canal of the allantoid vesicle, which afterwards takes the name of 'Urachus.' 5. Two umbilical arteries, and two umbilical veins, which accompany the allantois to the chorion. 6. Large oval transparent cells, surrounding the umbilical vessels, and containing a viscid matter, known as the gelatin of Wharton.

This diagram (fig. 22), from Wagner's Physiology, shews the relation of the various parts of the ovum to the embryo in the centre. The embryo is suspended by the umbilical cord in the cavity of the amnion, and the way in which the pedicles of the allantoid and umbilical vesicles enter into the composition of the cord is well delineated.

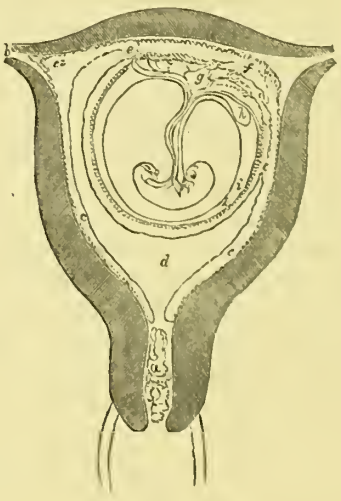

Fig. 22.

Sectional plan of the uterus and ovum—*a*, gelatinous mucous plugging the cervical canal; *c*, the decidua uteri, sending a prolongation, *c* 2, into the right Fallopian tube, *b*; *e*, *e*, the points of union between the decidua uteri and *d*, ovuli; *f*, the decidua serotina, united with the allantois, *g*, to form the placenta; *h*, the umbilical vesicle sending its pedicle with that of the allantois into the umbilical cord; *i*, the innermost membrane or amnion, enclosing the liquor amnii and embryo, and giving a covering to the cord; *k*, the shaggy membrane, or chorion, united closely with the decidua ovuli or reflexa.

Shortly after this period, obliteration of the umbilical vesicle and

its duct begins to take place, and progresses from the chorial extremity of the cord towards the abdomen of the fœtus; consentaneously with this the omphalo-mesenteric vessels become effaced, their function ceasing with that of the vesicle. As the vitellary duct is continuous at an early period with the intestine of the embryo, and indeed seems but a diverticulum of that canal, it is readily understood that a portion of the intestine forms then one of the constituents of the cord, and may be enumerated as the seventh element in its composition. With the progressive obliteration of the vitellary duct, however, the portion of intestine contained in the cord is more and more circumscribed, and at last shut entirely within the abdominal cavity of the embryo. Instances occasionally occur in which this closure at the umbilicus is imperfect, and in these cases we have a knuckle of intestine protruding through the ring, and constituting a congenital umbilical hernia—the condition being simply a permanence of a previously existing stage of embryonic development. The umbilical vein which at an early period accompanies the right umbilical artery soon disappears, and although we have two umbilical arteries permanently in the cord, there is only one umbilical vein. The constituents of the funis in the later months thus become normally reduced to—1. Two umbilical arteries; 2. One umbilical vein; 3. Surrounding cellular tissue, containing the gelatin of Wharton; 4. A double covering derived from both chorion and amnion—the sheath afforded by the latter membrane being most external, and being continuous with the epidermis of the embryo at the umbilicus.

The vessels of the cord are originally straight; but as gestation advances they assume the spiral form, passing in the proportion of nine cases out of ten from left to right as they emerge from the umbilicus. The arteries are much longer than the vein, and wind round the latter in serpentine coils; on the other hand, the vein has a much wider calibre than either of the arteries, and its walls may be said to have undergone development in a lateral direction, while those of the arteries have become more and more elongated. The vein is not provided with valves, but its tortuous course, and the frequent presence along its canal of dilatations, resembling pouches or diverticula, answers in some measure the same purpose, and must moderate the flow of blood back from the placenta towards the right side of the fœtal heart. I do not propose here to enter into the anatomy and physiology of the fœtal circulation; it is sufficient, in connection with this subject, to inform you that

every time the fœtal heart contracts, a portion of the blood contained in the aorta is projected into the umbilical arteries, passes then into the fœtal portion of the placenta, and returns purified, and charged with nutrient and respiratory matters for the purposes of the embryo by the umbilical vein. The latter vessel thus fulfils a function analogous to that of the pulmonary veins, which return the blood purified by aëration to the left side of the heart after birth. These, so far as we know, are the only instances in the body in which veins are made to contain a purer blood than the arteries corresponding with them in distribution—the converse being the general rule.

The arteries of the cord pulsate, therefore, in unison with the fœtal heart; and their pulsation may be observed sometimes to continue fifteen or twenty minutes after birth; but the impulse ceases spontaneously after that time, the blood having betaken itself to other channels. From the evidence of several observers, it seems pretty certain that the coats of the umbilical arteries possess a vital contractility of their own, independent of the fœtal heart. Osiander and Naegele saw the cord pulsate after the heart had ceased to beat; and Dr Simpson has shewn that, by pinching or otherwise irritating the vessels, their calibre becomes so contracted as almost entirely to close the tube. The reason why these arteries, in the later months of pregnancy, have a spiral arrangement in the cord, and why they wind almost constantly from left to right, is not yet very clearly ascertained. M. Velpeau accounts for it by supposing that the embryo turns round an imaginary axis in the amniotic cavity, and so twists them as to give a permanent spiral direction. Van der Kolk, on the other hand, believes this peculiarity to depend on a cause totally different. In the essay previously alluded to, he enunciates the hypothesis, that the spiral arrangement occurs from the resistance which the blood encounters when projected into the umbilical arteries, by which the side of the pelvis of the fœtus is made sensibly to recoil with each pulsation, and a movement of rotation is thus produced in the body of the embryo, by which the vessels become twisted into the form usually observed.*

* The late John Simpson, Esq. of Haskar, shortly before his death, published a most ingenious essay, the object of which was to point out that the direction of the spiral in the umbilical cord is due to certain anatomical peculiarities of the fœtal vessels, the influence of which has hitherto been overlooked. Mr Simpson shews that the right hypogastric artery is larger, and a more direct continuation of the trunk of the

The coats of the arteries are much stronger than those of the veins, and when the cord is divided, the arteries may be distinguished in the section by their greater thickness and contracted but yet patent orifices—the vein from its thinner walls, and less elastic structure, collapsing at once when emptied of its contents. You may observe what are called false knots frequently in the course of the arteries; these are simple loops or knuckles of the vessel, arising from the unequal and rapid development in its longitudinal axis. They are said to be more frequent in primiparæ, and midwives in Germany profess to calculate the future fecundity of a mother from the number of these loops. In addition to the false knots, it is not uncommon to meet with true knots on the funis. Baudelocque has figured several varieties, beginning with the simple knot, and increasing in complexity until the cord appears woven into a net-work. Probably many of these knots are formed early in pregnancy, when the fœtus is small, and the liquor amnii is large in proportionate quantity. A true knot may no doubt be formed late in gestation, or even during labour, if the cord be inordinately long, and the fœtus passes through a coil of it. The distinction pointed out between those formed early in pregnancy and those formed later or during labour is, that when untied the latter have no tendency to re-coil themselves into the knotted position, while in the former it is impossible, without tearing, to make the cord keep a straight form. M. Baudelocque asserts that in no instance have these knots been known so to interfere with the placental circulation as to cause death of the child, although an opposite opinion has been held by some authorities.

When the cord attains any considerable length, it is generally coiled once or twice round some portion of the body of the child, and thus provision is made against prolapse—a very fatal complication to the child during labour—in those very instances where we may readily conclude there is the greatest proclivity to it. Dr Churchill states that this coiling of the funis occurs as often as once in every nine labours. In future practice you will frequently find it tightly encircling the neck of the child, when the head has

aorta than the left, and believes that the preponderating force of the blood current in the right, causes a rotation of the fœtus in such a way as to determine the direction of the twist so constantly observed from left to right; and also offers an explanation of the fact, that in most instances where the cord is coiled round the neck of the child, it takes a direction from the umbilicus over the right shoulder, across the nape, then forwards by the left side of the neck, and so on according to the number of the convolutions.—(*Sept.* 1859.)

emerged from the vulva of the mother, and it needs then to be slipped over the head or body of the child; for, although in all probability original shortness of the cord, or shortness produced by its being wrapped round the body of the child, have not the slightest influence in obstructing labour in the previous stages, yet when the head has emerged from the external parts, it may possibly hinder the completion of labour; may be torn and separated from the placenta, if we endeavour forcibly to extricate the child; or, lastly, when coiled tightly round the child's neck, it may so compress its trachea as to interfere with the first inspirations, and threaten death from asphyxia. In Dr Montgomery's 'Signs of Pregnancy,' and in Dr Simpson's works, may be found records of instances in which the cord was wrapped so tightly round the limbs of the fœtus as to lead to indentation, to atrophy, and it is supposed even to amputation *in utero*. Such cases are, however, extremely rare, and rank among the curiosities of Obstetric Science.

The thickness of the cord in the later months depends upon the quantity of albuminous material surrounding the vessels, which is called the 'gelatin of Wharton.' It consists of a viscid fluid contained in delicate meshes, and has been described as bearing a resemblance to the vitreous humour of the eye; the meshes are probably formed by the enlargement and coalescence of the oval cells which surround the vessels at an earlier period. Nerves have not been demonstrated anatomically, but their presence in the cord is inferred from several circumstances connected with its physiology and pathology. The irritability of the coats of the vessels, the alleged independent pulsations of the arteries, and, moreover, the growth and nutrition continuously going on, which in every other part of the body is intimately associated with nervous influence—all point to the same conclusion. The existence of lymphatics, although doubted by Hunter, seems to be proved by the experiments of Fohmann in Germany, and by those of Dr Montgomery in Dublin. The last author succeeding in injecting a fine net-work of them, and remarked that they follow for the most part the course of the umbilical arteries.

Anomalies in the structure and appearance of the funis occur chiefly from early division of the vessels; from persistence of earlier stages of development; from accident or disease. Instead of continuing undivided throughout the cord, the branching of the arteries has been known to take place near the body of the fœtus

—the divisions entering the membranes at a point distant from the placenta, and running on beneath the amnion until they reached the substance of the after-birth. Again, the vessels of the cord have been found separated from each other, and loosely enveloped in a sheath of the amnion; and lastly, the number of vessels may vary, two umbilical veins being found at the full time, as in the primitive structure of the cord, or one artery only may be present, some accident having obliterated its fellow.

When the uterus contains twins or triplets, there is usually a separate cord for each child, which connects it with its own placental mass. Rarely the two cords have been found united by a vessel passing between them, but generally the circulation of each fœtus is separate and distinct.

Some authors have described cases in which no umbilical cord was present in the gravid uterus at all, the fœtus being directly united to the placenta. It is difficult to conceive how such an anomaly could exist, and M. Velpeau is inclined to doubt the authenticity of the instances adduced; possibly some fallacious anatomical condition of parts may have led to a wrong conclusion in these cases. Examples every now and then occur of morbid adhesion of the cord to some part of the body of the fœtus; when this happens it is generally associated with some malformation of the latter, exactly as we saw distortion accompany growth of the placenta to the body of the fœtus.

Normally, the cord swims about in the liquor amnii in the same manner as does the fœtus; or, as we have seen, it may be wrapped round some part of the body of the child, and when labour supervenes, and the membranes are in due course ruptured, the head descends on the os uteri, and plugs the aperture, preventing the escape of a loop of the funis until the head has passed through the maternal passages. In the proportion of about 1 to every 200 labours, however, it is found that from some accident, such as the sudden escape of the waters before the presenting part of the fœtus accurately adapts itself to the genital passages, the cord becomes prolapsed, and protrudes into the vagina before the child. In such circumstances the life of the offspring is placed in imminent jeopardy, and it is found that notwithstanding all the appliances which science and art can furnish to combat the effects of the accident, scarcely one half the children are born alive. When the funis so presents itself, it is liable to become pressed between the advancing body of the child and the canal through which it

has to pass, and thus the circulation between the fœtus and placenta is suspended, and speedy death ensues to the child. Many measures have been suggested for replacing the cord in the uterus above the presenting part; some have proposed slowly to return it with the fingers like a hernia, bit by bit, and retain it by a sponge in its replaced position; others have employed various mechanical expedients to effect the same end; and lastly, these means being impracticable, it has been recommended to shield the cord as much as possible from the injurious effects of pressure, by placing it in the opposite pelvic diameter to that in which the head is engaged. I fully believe that the method lately suggested by Dr Thomas, of the United States, and which has, I understand, been taught for many years previously in this theatre by my colleague Mr Bloxam —that of placing the mother on her elbows and knees, by which the fundus uteri is allowed to gravitate, and so to become the most dependent portion of the organ, will, in many cases, prove to be the best. In this way the knuckle of prolapsed cord will in all likelihood slip back spontaneously into the uterine cavity, or it may possibly be assisted by gentle taxis, which without the advantage of the favourable position might be perfectly useless.

The umbilical vessels sometimes become obstructed from the effects of disease, and any such obstruction of course acts injuriously on the child in proportion to its amount. I have seen one artery so occluded as to be impermeable to injections, without sensibly affecting the welfare of the new being, the entire afferent circulation being carried on by the other pervious artery. If both arteries cease to transmit the blood current the fœtus perishes, and the same will happen if the vein is plugged or obliterated from any cause. The vessels are sometimes torn across both before and during labour; a violent concussion to the mother is said to have ruptured the cord before the supervention of labour; and rapid delivery, or some accident, may effect this during the process. If the hæmorrhage be considerable, you will recollect that the child only suffers from it.

In the management of labour we divide the umbilical cord between two ligatures placed two or three inches distant from the navel. The ligature nearest the fœtus prevents hæmorrhage from the child, but that next the placenta is simply a matter of cleanliness, and a provision against the possible presence of a second child *in utero*, which would otherwise suffer from loss of blood did any connection exist between the circulation of the twins. The

piece adherent to the umbilicus of the infant gradually shrivels, loses its vitality, and falls off about the fifth or sixth day. The shrinking progresses towards the navel, and when separation has occurred, a red spot, like a round ulcer, is visible ; this usually causes no inconvenience, and becomes perfectly healed in a few days ; indeed, the healing process is often nearly completed before the decadence of the cord.

LECTURE VII.

The Development of the Walls, Vessels, and Nerves of the Gravid Uterus; and the Changes in Form, Size, and Position which it undergoes during Pregnancy.

THE changes which take place in the parietes of the uterus during pregnancy are not less remarkable than those which I have described as occurring on its internal surface. The healthy virgin uterus usually weighs little more than an ounce, and presents an average length from os to fundus of about three inches. But when emptied of its contents and contracted at the term of gestation, the womb has so far increased the quantity of its organic tissues that it commonly weighs as much as twenty-four ounces, and measures in length fully eight inches. This enormous increase in size is mainly produced by an augmentation of the elements which form the middle coat—the thick fibrous layer which lies between the peritoneum externally and the mucous membrane internally—and which constitutes the proper uterine tissue. If you examine an unimpregnated uterus, you will find that the uterine tissue is pale, firm in texture, possesses little elasticity, and is permeated by minute channels, which are its nutrient blood-vessels. In making a preparation for the microscope, the fragment is tough, and its elements separated with difficulty. It consists, however, of layers of fusiform fibres or spindle-shaped fibre-cells with oval nuclei; of elongated and rounded cell-particles; and amorphous granular matter. These are imbedded in a matrix much like the stroma of the ovary, and alternate with layers of a fibrous tissue, the fibrillæ of the latter having a wavy outline closely resembling white fibrous tissue in other parts of the body. All these elements are united so closely together that their isolation is most difficult, but the fibre-cells are distinctly seen after the addition of a weak acid, which renders the fragment transparent.

The tissue of the gravid uterus, again, is spongy, full of large dilated vessels, and its component parts are more readily separated. The parenchyma of the middle coat now consists for the most part

Fig. 23.

Rounded and fibre-cells found in tissue of the unimpregnated uterus.

of colossal smooth muscular fibres, each possessing a faint elongated nucleus; the transparent matrix is scarcely visible, and wavy fibrous tissue, except in the track of the blood-vessels, appears in small proportionate quantity. The cell-particles and fusiform fibres found in the non-pregnant uterus are, in fact, embryonic muscular elements, lying dormant until the stimulus of impregnation is

Fig. 24.

Colossal muscular fibres, with nuclei from uterus in the eighth month of pregnancy.

applied, when they at once take on development, grow into well-developed organic muscular fibres, and by their united contractile power become the active agents in expelling the fœtus when gestation is completed. According to Kölliker this formation of new muscular fibres occurs chiefly during the first half of pregnancy, but ceases after the sixth month, and after that period none of the earlier forms from which they are produced can be found. Some idea may be formed of the aggregate development which goes on

in the muscular coat from the statement of the author just mentioned, that each separate fibre-cell of the unimpregnated uterus increases during pregnancy from seven to eleven times in length, and from twice to five times in width. The round and oblong cells also advancing in organisation and growing into muscular fibres, we have as a result of impregnation not only a great increase in the size of fibres already existing, but also a creation of new fibres from the accompanying cell-particles. These progressive changes may be traced conveniently in the uteri of cows and sheep, which may be procured at various periods of gestation. In these animals the large muscular fibres may be isolated with greater ease than in the human subject, and their large elongated nuclei, which are defined with some difficulty in a woman's gravid uterus, are readily apparent. Mr Rainey, who published some years ago an excellent paper on this subject in the *Philosophical Transactions*, has indeed described the large muscular fibres of the human uterus as destitute of nuclei at the completion of pregnancy; but I believe the nuclei may generally be detected in some part of the course of the fibre by a careful search and the proper use of chemical re-agents. In the fundus and body of the organ the development of muscular tissue takes place pretty equally throughout the thickness of the middle coat. We may except, perhaps, the more external layers adjacent to the peritoneal coat. Here, there is a much larger admixture of white fibres, which by their presence give strength and tenacity to the uterine walls, enabling them to bear with impunity the increasing distension of pregnancy and the tension to which they are subject during labour. In the cervix uteri there is a less considerable development of muscular fibres and a larger proportion of wavy fibrous tissue, probably for the reason that the cervix is less concerned in the expulsive efforts of labour than the rest of the organ.

It is almost impossible in the nulliparous uterus, even with the most skilful dissection, to make out any definite arrangement in the fibrous structure of the middle coat; but in the later months of gestation, when the larger muscular fibres are developed, they are arranged in layers or bundles, and their direction may be traced somewhat more easily. The interlacing of the fasciculi is, however, so intricate that the most able anatomists have done little more than indicate the tendency to certain anatomical plans. Ruysch, Weistbrecht, Mde. Boivin, and more recently Kölliker and M. Deville, have each given more or less elaborate descriptions of the

anatomical arrangement of the muscular fibres in the gravid uterus, and each account differs very considerably in detail.

A general notion of their disposition may be gained, however, by recollecting that the human uterus in the course of embryonic development consists of two lateral segments fused together in the median line: the organ is, in fact, at an early period of intra-uterine life, bicornuous, like the uteri of some of the lower animals; and in adult age the muscular fibres are arranged rather in relation to the original tube out of which each lateral half is formed, than in relation to the entire organ. Thus, if an uterus at the full time be inverted and the internal muscular layers exposed by removing what remains of the decidua, the fibres in each lateral half of the body and fundus are seen to be arranged round the Fallopian aperture, as a centre, and gradually spread outwards in wider circles to the median line. Other fasiculi, which may be looked upon as fibres of fusion, pass directly from the fundus to the cervix in the median line, and some pass transversely entirely round the lower part of the body, and may be traced as circular bands as low as the os uteri. Transverse and longitudinal fasiculi can also be made out on the external surface when the peritoneum is removed; but the most prominent muscular layer on the outside of the uterus is one described by Sir Charles Bell, and called after him 'Bell's muscle.' This consists of strongly marked muscular bundles, taking their origin at the insertion of the round ligament on each side, and radiating outwards over the body and fundus of the uterus both anteriorly and posteriorly. Sir Charles Bell believed the round ligaments to have the relation of tendons to these muscles; and Mr Rainey has noticed that these ligaments become thicker and more muscular during gestation. The intermediate muscular fibres which lie between the external and internal layers, have a much more intricate arrangement, and pass among the vessels in every direction. Their intimate relation to the distribution of the blood-vessels was first pointed out by Sir Charles Bell; and it is especially notable at the placental site, where, as we have seen in a previous lecture, it probably exerts a most important influence on the prevention of hæmorrhage after separation of the placenta.

The question was long debated among anatomists, whether the uterine tissue proper is really muscular before the occurrence of impregnation. There can be no doubt, I believe, that it possesses contractile properties, as it expels blood-clots, dysmenorrheal membranes, and intra-uterine polypi. During the extrusion of these

we may sometimes distinctly recognise the alternate hardening and relaxation of the organ by placing the hand over the hypogastric region. Its muscularity at the full term of pregnancy scarcely admits of room for controversy. Almost every authority admits that it is the chief agent employed in the expulsion of the fœtus; for independent of what we know of its histology, during every efficient labour pain it may be felt contracting firmly on its contents; and you will learn to your personal inconvenience with how much force it presses on the fœtus, if, after introducing your hand into the uterus for the purpose of turning, you forget to lay it flat upon the child, and get your fingers wedged in an awkward position during the recurrence of a forcible expulsive effort.

The external or peritoneal coat, beyond an increase of growth as well in extent as in thickness, does not undergo any recognised histological changes. During the enlargement of the uterus there is an immense addition to the number of epithelial particles which compose its glistening free surface, and the fibrous tissue beneath, which serves as a means of union with the muscular coat, greatly increases in quantity, thus adding strength to the uterine parietes, and enabling them effectually to resist laceration either during the distension of the womb in advancing pregnancy, or during the powerful contractions which take place at the time of labour.

The broad ligaments, which are formed of reflections of the peritoneum on each side of the uterus, were supposed by William Hunter to become unfolded, and thus afford a covering to the pregnant uterus. It may readily be shewn, however, that the alæ are quite inadequate for the purpose supposed, and that although somewhat stretched, they may be found attached to the lateral margins of the uterus at the full time, and almost equal in measurement to those appended to a non-pregnant uterus. With our present knowledge of the extraordinary development which goes on in the other uterine tissues as a result of impregnation, such an explanation is too mechanical to be satisfactory; and it need excite no surprise that the peritoneal coat really extends its surface in conformity with the rapid growth of the uterine tumour, by a rapid generation of additional cells and fibres.

After what has been said concerning the utero-placental circulation, little remains to be added on the development of the blood-vessels in the gravid uterus. The arteries and veins increase *pari passu* with the uterine growth; and the immense size they attain near the end of pregnancy is accounted for by the fact, that not

only have the greatly hypertrophied walls to be nourished by them, but they also supply all the demands of the fœtus and its appendages for growth and nourishment. The arteries, of less calibre than the veins, have a peculiar spiral course in passing through the uterine walls—a form of arterial distribution which, so far as I am aware, is peculiar to the uterus, and does not occur in any other organ. The veins are without valves, and form large flat channels which appear as excavations in the uterine tissue. Their walls are so blended with the muscular substance, that to dissect them out would be almost impracticable. They are especially large near the insertion of the placenta, several trunks converging to form large cavities, and these receiving the name of uterine sinuses. Kölliker has shewn that as the venous channels increase in size, their middle coat, which before consists of contractile cells, now begins to develop actual muscular fibres, and that these blend and unite themselves with the muscular uterine fibres proper, being scarcely distinguishable from them.

The lymphatics, which are small and unimportant in the unimpregnated uterus, develop and widen during pregnancy almost equally with the blood-vessels. They are demonstrated with difficulty in the former; but in the latter weeks of gestation some of the trunks attain the size of a quill, and in Livraison 13, plates 1 and 2 of Cruveilhier's Morbid Anatomy, they are represented filled with pus, as they are found in some forms of puerperal fever; and their complexity and large size are well delineated.

The womb is supplied with Nerves, derived from the sympathetic and cerebro-spinal systems, which pass to it from the hypogastric, spermatic, and sacral plexuses. The question as to whether they enlarge during pregnancy has been hotly contested; and amid the conflicting evidence adduced, it is extremely difficult to arrive at a satisfactory conclusion. Dr Robert Lee takes the foremost place among those who answer in the affirmative; and in the Museum of St George's Hospital you may see the dissections on which he bases his opinion, and which must have cost him no small amount of patient toil, as well as careful manipulation. On the other hand, Hirschfeld, M. Robin, and Dr Snow Beck, inform us that there is no actual increase of nerve-substance, and that the thickening observed during gestation is simply an enlargement of the investing sheath or neurilemma. Dr Beck, after very careful dissections, aided by the microscope, and undertaken, as he tells us, with the view of attesting the truth of Dr Lee's views, asserts that after

removing the neurilemma entirely, there was no difference between the size of the nerves in the non-pregnant and gravid uterus. It must be admitted, however, that reasoning analogically, and from what we know concerning the distribution of nerves in other parts of the body, the inference is on the side of those who assert that the uterine nerves enlarge during pregnancy. Wherever we have large vessels ramifying, there we have nerve-filaments in close attendance; and wherever the process of nutrition is actively going on, or a large muscular development present, the supply of nerves to the part bears some sort of direct relation.

The researches of Dr Franz Kilian described by Kölliker, indeed, seem to throw some light on the matter. According to Kilian the extremities of the uterine nerve-tubules before conception are in an undeveloped or embryonic condition, and are scarcely visible; but with the occurrence of pregnancy these terminal nerve-tubules become medullated and dark bordered, consentaneously assuming a higher function. The nerves may thus be said to increase potentially in length, while they increase in thickness by additional growth of the fibrous investing sheath; the latter being especially necessary as a protection to the nervous trunks, under the pressure to which they are exposed during pregnancy and labour.

During gestation the cervix uteri undergoes peculiar modifications in texture and form, which need a separate description. With commencing pregnancy, the cervical cavity bounded above and below by the os internum and os externum respectively, becomes expanded, and the secretory function of its mucous follicles exalted. A plug of thick, tenacious mucus forms in this situation, and seals up the uterine cavity proper from the ingress of air or other matters. That portion of the cervix uteri which projects into the upper extremity of the vagina requires special attention, as the alterations which occur in it are within reach of a digital examination, and are of considerable value in assisting us to form a correct diagnosis as to the existence of pregnancy. Very shortly after conception the practised hand is able to appreciate that this portion of the cervix is more tumid, softer, and more elastic, yielding to the finger, as Dr Montgomery describes it, 'a sensation of a softer tissue overlying a firmer.' The os uteri changes its transverse form, and feels more rounded; its margins are less distinct, the pouting of the labia uteri rounding off its edges, and the mucous secretion of its surrounding follicles imparting a smoothness not previously possessed. By the aid of the speculum the lower end of the mucous

plug filling the cervix may often be seen at the orifice; but here, instead of being transparent, as in the rest of its extent, it is white and opaque, probably, as Dr Tyler Smith has shewn, from its coming in contact with the vaginal mucus, which has an acid reaction—the uterine secretion being alkaline. As time elapses, the os uteri internum gradually dilates, and thus the cavity of the cervix becomes continuous with, and forms part of the general cavity of the uterus. The result is, that in the later months there is less and less projection of the portio-vaginalis into the upper extremity of the vagina. It is especially during the last four months of gestation that this process of 'shortening,' as it is termed, takes place. In the unimpregnated uterus the cervix usually projects like a large nipple, somewhat less than an inch below the attachment of the vagina. For the first five months, little change in this amount of projection downwards is observed, but at the termination of the sixth month, shortening with increase of breadth, is decidedly appreciable, and at the end of the ninth month the os is nearly on a level with the attachment of the vagina. Thus, before labour begins, the child lies in contact with the inner margin of the os externum, with the membranes only intervening, and the fœtal head is felt through the uterine walls as a globular tumour at the upper extremity of the vagina. It is usual to describe the shortening of the cervix during the last four months of pregnancy as divisible into four definite portions; and taking the amount of projection at first as one inch, the shortening is said to be at the rate of a quarter of an inch per month—the first quarter thus disappears at the end of the sixth month, and the last at the end of the ninth. Such a description can only be regarded as approaching somewhat to the real facts of the case; as a rule for guidance in diagnosis, it is far too arbitrary. In first pregnancies the tissue of the cervix is generally more unyielding than in subsequent ones, hence it results that often the cervix is shortened in a less degree; in other women again, particularly those who have previously borne large families, there is little, perhaps no projection at all of the cervix into the vagina, even at the commencement of pregnancy; and certain pathological conditions may produce the same result.

M. Stoltz and M. Cazeau affirm that the shortening of the cervix during the last months of pregnancy is not produced, as hitherto taught, by the dilatation of the os uteri internum, and the gradual drawing up of the cervical chamber to form part of the general uterine cavity. It is the opinion of these authorities that the

internal orifice does not undergo dilatation until within a few days before the commencement of labour, and that previous to this period shortening is due to a sinking down of the neck of the womb upon itself, which brings the external and internal orifices nearer to each other; enlarges laterally the cervical cavity: and at the same time shortens its vertical diameter.*

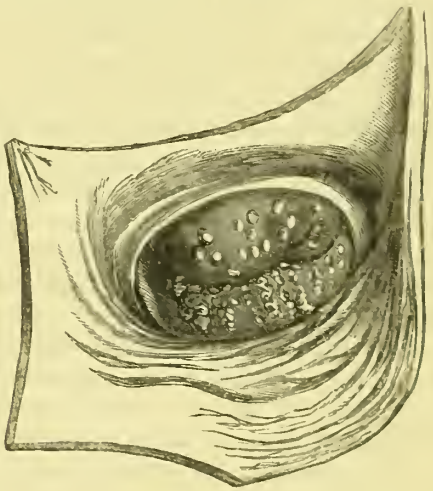

Fig. 25.

Cervix uteri in the seventh month of pregnancy, shewing its shortened and lobulated condition, with projecting mucíparous glands over the labia uteri (after Montgomery).

Fig. 25, copied from Dr Montgomery's Signs of Pregnancy, represents very graphically the shortening, as well as the tumid and lobulated condition of the cervex uteri in the seventh month; it also shews the enlargement of the mucous follicles over the lips of the uterus, which, undergoing hypertrophy, like the rest of the

* Lately, Dr Arthur Farre and Dr Matthews Duncan have separately expressed their conviction that the shortening of the cervix in the last four months of pregnancy is in no way connected with the taking up of the cervix to form part of the uterine cavity, and each has recourse to an explanation very similar to that offered by M. M. Stoltz and Cazeau. There can be no doubt that in multiparæ during the later months of pregnancy, the os uteri externum and cervical cavity are often so widely dilated as to admit the finger, while the os uteri internum is yet closed. On the other hand, in primiparæ the os uteri externum generally remains closed until the beginning of labour, the internal orifice having yielded previously so as to allow the child's head enclosed in the membranes to be felt just within the os tincæ. As the subject has some important bearings, in a medico-legal point of view, the whole question deserves a carefnl revision by obstetric authorities.—(*Oct.* 1859.)

tissues, may frequently be felt during an examination rolling under the finger like small visicles.

The shape and volume of the entire uterus vary with the duration of pregnancy. At the commencement, as the ovulum generally attaches itself to some portion of the uterine cavity near the fundus, the fundus becomes first expanded, and the development of the body and cervix take place subsequently. For the first five months the gravid uterus gradually loses the pyriform shape of the unimpregnated organ; the anterior surface formerly flattened is now rounded and projecting, and the fundus and body assume the form of a globular tumour, while the cervix, in shape at least, is as yet little altered. Later, the cervix, too, is expanded, and its cavity forms part of the uterine chamber. The organ then approaches the form of a large ovoid, with its larger extremity at the fundus. In the later months, therefore, the cavity corresponds to the normal position and form of the fœtus, which at the full time is so folded up *in utero*, that it constitutes a corresponding ovoid body, the head, which is towards the os uteri, forming the smaller end of the ovoid; the nates, with the flexed lower limbs, forming the larger extremity, which lies towards the fundus uteri.

In the fourth month the uterine tumour may usually be felt through the abdominal parietes, above the brim of the pelvis. Previous to the end of the third month the gravid uterus is a pelvic organ, and is too small to be appreciable by external examination. The immediate effect of impregnation is, in fact, to make the uterus sink lower in the pelvis, and the os uteri thus approaches nearer to the vaginal orifice. From this gravitation of the enlarged organ arise certain annoyances incident to the pregnant condition; irritation of the bowels and bladder, giving rise to diarrhœa, frequent micturition, &c.; and physical pressure on the pelvic nerves and vessels, giving rise to cramp, œdema, and varix.

In the fourth month, however, the uterus, on account of its increasing size, can no longer be accommodated in the pelvis, and rises gradually out of it, to become an abdominal organ. What is termed 'quickening' generally occurs about the same time, the ascent of the uterus frequently corresponding to the period when the fœtal movements are first appreciable to the mother.

At the end of the fifth month, the fundus uteri is midway between the pubis and umbilicus; at six months, the umbilicus is reached; at the seventh month, it is half-way between umbilicus and ensiform cartilage; and at the end of the eighth month, the

ensiform cartilage itself is reached; a little recession from this often occurring afterwards from the yielding of the abdominal parietes.

As the uterus ascends in the abdominal cavity it comes in contact with the abdominal parietes, and lies in front of the intestines. The bowels, as well from their attachment by the mesentery as by their specific lightness, mount above it, and rest upon the fundus, or are arranged in a lateral position with regard to it. The arch of the colon usually encircles its outer boundary, and the omentum is so pushed up that it lies in folds in the epigastric region.

The relations of the uterine appendages are considerably altered during the development of the gravid uterus. The round ligaments, instead of passing horizontally forwards, have their uterine extremities so elevated that they descend almost perpendicularly to the inguinal rings. The broad ligaments, although not, I believe, unfolded, as stated by William Hunter, appear stretched and dragged upwards, and the Fallopian tubes and ovaries are attached proportionately lower than in the unimpregnated uterus, and hang downwards from the sides of the organ. The tubes are more fleshy and vascular, and their fimbriæ and internal rugæ larger and more beautiful, especially when the vessels are injected.

The ovaries are little altered, except the one which contains the corpus luteum; this is more rounded, and has a prominence on its surface, upon the summit of which appears the cicatrix formed after the discharge of the ovum.

At the end of the ninth month the uterus is not usually filled to tenseness; on the contrary, it is but moderately distended. Occasionally, however, from superabundance of liquor amnii, or the presence of more than one child, it is immoderately stretched, and gives rise to much uneasiness during pregnancy, and later to lingering labour.

Commonly, as William Hunter has pointed out, it resembles a bladder of water not quite full, being plastic and moulding itself to the adjacent structures. Thus the lower end of the uterus, with the head of the child being contained in the pelvic cavity, the brim of the pelvis has the effect of a belt girding that part of the uterus, and makes a circular indentation in its parietes. The figure is also modified by the different attitudes of the mother's body, any projecting point against which the uterus may gravitate producing a corresponding concavity in its parietes. The yielding property of its walls permits it also to adapt itself to the varying attitudes and movements of the fœtus. So great is the modification of form of

which it is capable, that in cross-presentations the organ is often broader from side to side than from above downwards, and entirely loses its regular ovoid figure. Twins may be present without any marked deviation from the normal proportions; but some curious exceptions are on record, one of the most remarkable being an instance related by William Hunter which occurred to Dr Mackenzie, where the uterus had stretched into two distinct lateral bags for containing the respective twins, a deep notch dividing the compartments on the external surface. It is probable, in this case, that some congenital malformation of the uterus existed previous to impregnation, the organ having in some measure retained the form of that period of embryonic development when it is bi-cornuous, as in some of the lower animals, and that a fœtus was developed in each lateral segment. The posterior aspect of the uterus at the full time is more flattened than the anterior, and the whole organ seems compressed from before backwards, being broader laterally than antero-posteriorly. The long axis does not correspond either to the axis of the brim of the pelvis or to that of the trunk. The brim runs in the direction of a line drawn from the middle of the sacrum, and passing upwards through the umbilicus. The long axis of the uterus at the full time usually inclines still more than this from the perpendicular; the os uteri being placed backwards in the upper part of the hollow of the sacrum, and being reached with difficulty until labour sets in, when the uterine contractions bring the entire organ into such a position that its axis corresponds more nearly to that of the pelvic inlet. The axis varies, however, with the position of the mother's body; falling forward, and approaching nearer to the horizontal line in the erect posture. In primiparæ the uterus stretches itself higher up in the epigastric region, because the abdominal parietes are more unyielding, and prevent the fundus falling forwards. In multiparæ, the abdominal walls being less resisting, permit the fundus to gravitate forwards; and in women who have borne large families, the belly, during pregnancy, frequently becomes 'pendulous;' the womb actually resting on the thighs when the sitting-posture is assumed. This obliquity is further encouraged by an abnormally narrow pelvis. William Hunter saw in a deformed pregnant woman, on whom the Cæsarean section was performed, the fundus uteri turned so far downwards and forwards that the navel and hypogastrium could not be seen, being on the under surface of the abdominal tumour, and the uterus had to be lifted up by the hands of assistants while the necessary incision was made in the hypogastric region.

It is well to bear in mind that the pregnant uterus does not always lie directly in the middle line; generally it has some inclination to the right or left side, most frequently the right, away from the disturbance occasioned by the varying distension of the sigmoid flexure of the colon and rectum. This lateral position is most marked in early pregnancy, and it is particularly observable when the bladder is distended. Unless this be borne in mind, it is not unlikely to lead to some serious error of diagnosis on the part of the inexperienced practitioner, to be mistaken, for instance, for an ovarian tumour, which generally has a lateral position in early growth.

LECTURE VIII.

The Condition of the Uterus after Delivery ; the Reproduction of its Mucous Membrane ; and the Involution of the Uterine Parietes.

BEFORE terminating this section of the course, I wish to direct your attention to the condition of the uterus after delivery, and the changes which it undergoes after being emptied of its contents at the end of gestation. The investigation of these matters has latterly occupied many able physicians and pathologists, and it is now generally believed that an accurate knowledge of the physiological changes which take place in the womb and its appendages during puerperal convalescence, is essential to a proper elucidation of pathological phenomena connected with this period.

Immediately after the act of parturition, the womb contracts in its entire dimensions, and may be felt hard and resisting, like a cricket-ball, through the abdominal parietes in the hypogastric region. At this period it is many times larger than the unimpregnated uterus, and presents, indeed, very different characters ; but examine it two or three months after birth has taken place, and, although it may remain permanently enlarged in a slight degree over the virgin womb, yet it will be found in most particulars to have returned to its pristine form and structure, weighing from one and a half to two ounces ; having a cavity little more than two and a half inches long ; and being lined with as smooth and perfect a mucous membrane as before pregnancy existed.

Let us inquire, first, into the condition of the inner surface of the uterus after delivery.

You are already aware that the decidua uteri, or outer envelope of the fœtus *in utero*, is a membrane of uterine origin, and really consists of the altered and hypertrophied mucous lamina which lines the interior of the womb. You are also aware that this

decidua or altered mucous lamina is a caducous membrane, and is expelled as part of the secundines at the termination of labour. The questions, therefore, naturally present themselves—What is the state of the inner surface of the uterus, after delivery? and by what reparative process does it regain the condition of the unimpregnated organ?

In reviewing the opinions of various authorities on these points, one is particularly struck by the amount of discrepancy existing among them, and the entirely opposite conclusions arrived at. William Hunter's opinion was, that at the time of delivery only a portion of the mucous lamina (that is, decidua) is thrown off with the secundines, a deeper stratum always remaining attached to the muscular coat as a protection to the interior of the organ; and this deeper stratum ultimately dissolving and coming away with the lochia. On the other hand, M. Cruveilhier, in his beautiful work on Pathological Anatomy, enunciates the doctrine that the larger portion of the uterus is entirely denuded of its inner covering. As he expresses it, 'except just at the inner surface of the cervix uteri, there is no mucous membrane at all, but the muscular tissue of the uterus is everywhere exposed. This therefore, like the stump, is to be covered by a new membrane.' Proceeding further with the analogy between the condition of the uterus after delivery, and a stump after surgical amputation, M. Cruveilhier teaches that the gaping veins at the placental spot are like the open-mouthed vessels of an amputated limb, and that the reparative process is associated with local inflammation of the organ—a false membrane being thrown over the surface previous to the formation of a new mucous membrane.

Several writers on puerperal fever, relying on M. Cruveilhier's statement, have drawn a parallel between the puerperal and surgical patient, both presenting a large open wound, with bare muscular substance exposed to external agencies, and both, therefore, being liable to the attendant dangers of such a condition. Dr Ferguson (from whose learned Essay on Puerperal Fever I have transcribed the preceding passage from M. Cruveilhier), concurs generally in M. Cruveilhier's description, but is inclined to think it somewhat exaggerated, and points out that the analogy drawn between the uterus and a stump so far fails, as that there is no solution of muscular continuity; and in one instance he personally examined, only the placental spot was denuded of mucous membrane, the remainder being covered by it, but much modified and changed.

Dr Rigby and others quote Cruveilhier's statement with approval; and Professor Simpson, in shewing the analogy between puerperal and surgical fever, has taken its correctness for granted. In an essay of great practical value, he has shewn that not only is there analogy between the anatomical conditions, the morbid lesions and symptoms of puerperal and surgical fever, but that, under certain conditions, the one may produce the other.

Quite recently Dr Heschl, of Bonn, has published a paper 'on the conduct of the uterus after delivery,' which has attracted much attention, and which has been translated by Dr Robert M'Donnell, of Dublin. Like M. Cruveilhier, Dr Heschl expressly asserts that except at the cervix, the mucous membrane is entirely thrown off at delivery, and the muscular substance is everywhere bare and exposed. Dr Matthews Duncan, again, entirely dissents from the assertions of M. Cruveilhier and Dr Heschl, as to the muscular substance being exposed. In several excellent contributions on this subject, he states his conviction, based on personal observation, that the mucous coat is never after a normal labour so far removed as to lay bare the muscular fibres. He further states, what is not quite in unison with my own observation, that 'the residuary decidua forms the mucous lining of the uterus,' fulfils, therefore, all the functions of a mucous membrane, and is not shed off, as William Hunter supposed, except 'in the regular insensible exfoliation of such structures.' Dr Chisholm, of Dumfries, in contributions to the *Edinburgh Medical Journal*, describes dissections undertaken by himself, both on the uteri of lower animals, and in the human subject. He also arrives at the conclusion, that in none is the muscular coat exposed after delivery, and asserts that in all he was able to demonstrate the follicular apertures of the mucous lamina which remained on the interior of the womb.

It very naturally occurs, in the first place, to inquire, how is it, if the doctrine propounded by M. Cruveilhier and Dr Heschl be correct, that in the ordinary course of things, when no epidemic influence prevails, the proportion of deaths after delivery is so small, compared with the mortality after amputations under like circumstances? And, secondly, if so large a wound is made in the interior of the uterus by the entire removal of its mucous membrane, how is it reproduced so perfectly and speedily, and without any remaining appearance of cicatrization? In reference to the last point, Heschl indeed asserts that a day or two after delivery the process of reconstruction commences from the mucous membrane

remaining on the cervix; or, if this does not exist, then from the exterior of the os by the extension of a firm net-work, which gradually spreads over the whole uterus. This explanation, however, seems by no means sufficient, and is not borne out by the results of other observers.

I have repeatedly had opportunities of examining the uterus after delivery, and the following description taken at the post-mortem examination of a primiparous woman who died the day after a very severe labour, applies pretty closely to the majority of instances I have examined under similar circumstances:

The uterus was contracted to about the size of a man's fist; its cavity was nearly seven inches long; its walls were thicker than in the unimpregnated condition of the organ, and looser and softer in texture; the veins were very large and numerous, but generally empty; the os uteri was irregularly ecchymosed, and its mucous membrane fissured; the internal surface of the uterus was covered everywhere with dark coagulated blood, but on carefully removing this and passing over the preparation a gentle stream of water, the uterine parietes were exposed. The interior of the uterus might then be described as consisting of three portions, each presenting different appearances. One portion near the fundus, equal to about a third of the whole, was recognised as the placental spot. It was more or less circular in form, slightly elevated above the rest, and darker in colour; its surface was lacerated and uneven, and shreds of tissue floated loosely out from it when placed in water. The orifices of the vessels which conveyed maternal blood to and from the placenta, and which were torn across in its separation, were readily distinguishable; dark clots plugging them, and projecting into the uterine cavity.

The second portion comprehended the remainder of the inner plane of the uterus as far downwards as a line corresponding to the os uteri internum; and the third lay between this and the os uteri externum. The former of these divisions had a reddish colour, was everywhere irregular as though torn, and when the organ was immersed in water, exhibited innumerable floeculent processes or shreds attached to it, similar to those on the placental spot, indicating the recent tearing off of a superimposed layer. Here and there could be seen bundles of muscular fibres, not unlike the columnæ carneæ of the heart, elevated above the surface, and sometimes quite smooth in outline as though bereft of all covering. No vascular apertures were visible here as over the

placental spot, nor was it possible to detect any of the pits or depressions indicating the follicular apertures. The flocculent processes from both the above-described divisions were found under the microscope to consist of cellular and fibro-cellular structures, largely mixed with fat granules, identical in form with those composing the deep layers of the decidua uteri in the latter months of pregnancy. None of the floating shreds consisted of lacerated bundles of muscular fibres, and even where muscular columns projected above the surface and were apparently denuded, a delicate investing layer of nucleated particles was invariably present. That portion of the interior corresponding to the cervix uteri, and bounded respectively by the os uteri externum and os uteri internum, presented very different characters to either of the portions yet described. Here was a mucous membrane as distinct as before pregnancy commenced; its rugæ were, however, unfolded, only slight traces of the arbor vitæ being discoverable, and lacerations appeared here and there, but in other respects it was unchanged and uninjured. A copious viscid secretion covered the surface, and the mucous follicles were detected even with the naked eye. The epithelium forming the membrane was traced as a continuous layer to the commencement of the body of the uterus, where it encountered the flocculent remains of the decidua and seemed to terminate.

I have little hesitation, therefore, in affirming, that after an ordinary labour the muscular substance is not laid bare, as erroneously asserted by some of the authors quoted; and that the shreds or flocculent processes observed hanging from the inner surface of the uterus are not muscular bundles, but really the remains of the decidua uteri—a stratum of which is left to protect the interior of the cavity until the mucous membrane is reproduced, when it breaks up and passes away in particles with the lochial discharge. So far as my observation goes, the stratum of decidua left on the uterine surface is essentially different in structure from the mucous membrane out of which it was formed originally, being composed of fibres and irregular cells mixed with fat globules, instead of the regular epithelial particles of a mucous lamina. Schroeder van der Kolk has traced the gradual shedding off of this layer of the decidua in the days subsequent to delivery, and he found that the large fibres which entered largely into its composition, and which he was able to distinguish from the uterine muscular fibres by their softer outline, undergo fatty degeneration.

and by this process are resolved into small fragments, which mingle with the discharges. The large admixture of blood-globules gives the saneous appearance to the lochiæ in the early days of convalescence; but later, when the blood-globules are less in number, an almost purulent appearance is produced by the cellular and fatty *débris*, resulting from the disintegration of the residuary decidua, and these constitute the chief part of the discharge.

The mucous membrane of the cervix uteri contributing nothing to the formation of the decidua, is found almost unchanged at the end of gestation.

It remains to inquire by what process is the mucous membrane reproduced and the cavity of the womb restored to the condition of the unimpregnated organ? In 1848 M. Robin published some researches, in the *Archives Gen. de Médecine* on the mucous membrane of the uterus, which have thrown much light on the subject. M. Robin, in the first place, draws attention to a thesis written by M. Collin, the object of which was to point out that the muscular substance is not denuded after separation of the membranes, and that the layer described by some authorities as pseudo-membranous or inflammatory in origin, found lining the interior of the uterus after delivery, is really a normal product, and consists of the deeper lamina of the original mucous membrane. Admitting the accuracy of this description, M. Robin proceeds to shew that M. Collin has not understood the physiological significance of the layer thus described as lining the uterus after parturition. According to M. Robin, indeed, this lamina is not a portion of the original mucous membrane, which took part in the formation of the decidua—this is thrown off at the time of labour—but it consists of an entirely new-formed mucous membrane, the first traces of which may be observed about the fourth month of pregnancy, and it continues to increase little by little to the end of gestation, when it takes the place and assumes the function of the pre-existing layer. Kilian has confirmed M. Robin's statement by observing the same peculiarity of development in the pregnant uteri of dogs and rabbits; and personal researches in the human subject have convinced me of the accuracy of M. Robin's investigations concerning the formation of a new mucous membrane in the latter half of gestation, although I cannot concede that the decidua is entirely removed at the time of labour.

In the uterus of a woman who died a few hours after abortion, at the end of the fifth month, I found under the remains of the

decidua, minute cell-particles, like irregular nuclei, everywhere spread over the muscular substance, and these nuclei had the same characters as embryonic epithelium beneath the more mature layers of mucous membranes generally. But more distinct evidence on this point is afforded by the following observation:—A woman in the last month of pregnancy died suddenly in the Edinburgh Maternity Hospital; and my friend Dr Keiller, who had charge of the case, gave me an opportunity of examining the uterus, the membranes being yet adherent to the uterine walls. I made thin sections with a sharp pair of scissors continuously through both membranes and uterine walls, and then carefully spread out the section for the microscope. The facility with which separation occurred, shewed at once the line of demarcation between the membranes and uterine walls; and in most sections thus prepared I was able to demonstrate a layer of nucleated particles, subtended by delicate fibrous tissue, lying between the muscular fibres and the decidua, and remaining adherent to the uterine wall when the membranes were removed. This nucleated layer did not

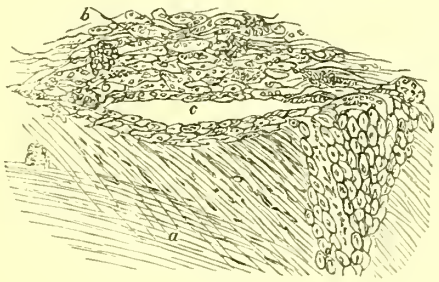

Fig. 26.

A section through the membranes into the uterine parietes in the last month of pregnancy. *a*, Uterine tissue with a layer of nucleated particles on its surface, and glandular follicles penetrating its substance. *b*, The decidua, its tissues loaded with fat granules. *c*, A space shewing the line of separation of the decidua from the uterine walls, leaving the layer of nucleated particles attached to the latter.

seem to me to be continuous over the surface, but was interrupted here and there by projections of fibrous tissue from beneath, which perforated it, and mingled with the decidual structure, thus forming points of attachment to retain the membranes *in situ*. Its component particles were clear and transparent, and formed a contrast to those of the decidua lying immediately upon it, which were loaded with fat granules. In several preparations appeared

sections of gland follicles of great length, which penetrated deeply into the uterine substance. Two or three canals of this kind were sometimes grouped together, and their cell-particles were entirely unaffected by atheromatous change. It is thus to be observed, that not only is a layer of young mucous membrane formed between the decidua and muscular coat of the uterus, but there are present also tubular follicles deeply planted in the uterine substance, which do not separate with the membranes, but remain as centres of reproduction to assist in spreading a thick secretion of epithelium over the surface of the uterus, when occasion requires.

The mode in which the uterine mucous membrane is further developed after parturition, is illustrated by the following description taken at the post-mortem examination of a patient who died on the seventh day after delivery, from disease unconnected with her confinement:—The internal surface of the uterus was somewhat less irregular than that observed in the woman who died the day after her confinement, but fragmentary portions of the decidua mixed with blood-corpuscles and fat globules were everywhere present, and the placental spot, though somewhat more contracted, was prominent and well marked. It was especially remarked, however, that the shreds of the decidua were less firmly attached than at the earlier period, and so loose that they were readily brushed from the surface. Immediately beneath was spread a pulpy layer, about the consistence of a jelly, which consisted of epithelial nucleated cells more or less spheroidal in form, and sparingly mixed with fat granules. The remains of the decidua were somewhat more firmly united to the placental spot; but even here the pulpy membrane was developing itself in meshes between the still noticeable but now contracted vascular orifices.

The summary of conclusions may be stated as follows:—

1. After an ordinary labour, terminating in separation and expulsion of the secundines, the muscular substance of the uterus is nowhere laid bare, as some authors have supposed, nor is there any inflammatory false membrane spread over the surface. As Dr Duncan has correctly pointed out, the interior of the uterus after parturition only bears analogy with the stump after amputation, inasmuch as both have large open vessels liable to be inflamed and to absorb noxious materials.

2. When the membranes are thrown off in the third stage of labour, a portion of the decidua remains attached to the uterine surface as a protection against external agencies. It is not, how-

ever, strictly correct to assert that original mucous membrane may be found everywhere lining the interior of the uterus after delivery; this is true only with regard to the cervix. The mucous membrane of the body, and fundus of the womb, were transformed into decidual structures at the commencement of pregnancy, and the laminæ of decidua found covering the surface of the interior of the uterus after delivery, has not the texture, nor can it fulfil the functions of a mucous membrane, but consists of an arrangement of cells, fibres, and fat granules, identical with those recognised in the decidua in the later period of pregnancy.

3. A new mucous membrane begins to be formed in the later months of pregnancy between the decidua and muscular coat. It undergoes a rapid development after the uterus is emptied of its contents; and as it is gradually perfected, it assumes the function of the original mucous coat. During the process the remains of the decidua undergo further fatty change, and are slowly shed off to mingle with the lochial discharge.

In cases where dysmenorrhœal casts and early ova are expelled from the uterus, the conversion of the mucous membrane into decidual structures is probably less complete, and the deep stratum remains behind to prevent the denudation of the muscular coat.

The diminution in the size and weight of the uterus after parturition is due mainly to atrophy of the muscular coat, or uterine tissue proper. The physiological process by which this is effected is peculiarly interesting, not only in its direct relation to the involution of the uterus itself, but also because it seems to be strictly analogous to a process of atrophy occurring in other organs as a pathological condition. Exactly as we have fatty degeneration occurring in the heart and voluntary muscles as a disease attended with wasting of substance and serious impairment of function, so in the uterus after delivery have we fatty degeneration set up in its muscular fibres, and their subsequent absorption as a normal process. It is doubtful whether the fatty change, as it occurs, for instance, in the voluntary muscles of the body, is to be regarded in itself as a form of disease leading to atrophy and impairment of function; or, on the other hand, looked upon simply as a degeneration subsequent to the loss of function—nature adopting this mode of removing what is effete and useless. But in the uterus, after delivery, we can trace the order of the phenomena, and satisfy ourselves that normally the cessation of function comes first. It is not until the muscular fibres have completed their function that

the fatty transformation ensues; but the end being accomplished for which they were developed, molecular disintegration reduces them to the form in which they can be absorbed by the vessels, and thus carried into the general circulation. Professor Retzius has remarked that the blood contains a larger quantity of molecular fat in the puerperal patient than in the non-puerperal one; and it deserves to be remarked that this increase corresponds with the new demands on the circulatory fluid, for the ingredients of the mammary secretion—fat being among the most important. So complete is the solution and absorption of the colossal muscular fibres which form the pregnant uterus, that in three weeks after confinement, they are no longer to be found in any part of the organ—the middle coat now consisting of embryonic elements, similar to those which composed the uterus before pregnancy began. Some authors have not hesitated to assert that the uterus undergoes so complete a transformation into molecular fat, and is thus so entirely disintegrated and absorbed, that not a single fibre of the uterus existing previous to childbirth remains behind. The fœtus of each succeeding pregnancy may thus be said to be furnished with a new uterus to sustain and protect it, which in its turn is disintegrated and absorbed. We are indebted to Professor M. Retzius, Drs West, Kilian, Kölliker, and Heschl for careful details of the mode in which involution takes place. The last-mentioned author states that the transformation of the fibres does not commence before the fourth or sixth day, and not after the eighth. 'In the single muscular fibres this process of decay begins at many points at once; at first the slight

Fig. 27.

a, Muscular fibres of the uterus eight days after delivery. *b*, The same fourteen days to four weeks after delivery. (After Heschl.)

serpentine appearance (fig. 27 *a*) disappears; the outline becomes pale, and there appear (often arranged in rows) yellow granules which, where the ends of the fibre-cells are thin, lead to their early

dissolution. The cell (or fibre) itself (fig. 27 *b*) is pale, but well defined, until the increasing quantity of fat granules obscures it.' Speedy absorption now goes on, and rapid diminution in the weight of the organ is the result. 'With the advance of the fatty transformation the uterus becomes in a corresponding degree friable, and continues so until it has completely returned to its usual condition.' The alteration produced by these changes gives a dirty yellow colour to the uterine tissue, and is readily recognised with the naked eye. By the fourth week the uterus has nearly regained its normal volume, and Heschl found at this time the first appearance of the new uterine tissue in the body of the organ—the reconstruction being complete at the end of the second month. The new tissue is probably formed out of the nuclei of the previous muscular fibres, as well as from other stored-up germs, which are not affected by the general absorption. The substance of the cervix has seemed to me more sparingly affected by the fatty transformation than the rest of the organ, which may be accounted for by the less amount of muscular tissue and the large proportion of white fibres present. The capacity of the vessels is diminished by the same process, and probably, also, the extent of the external or peritoneal coat. The enlarged and tortuous arteries, and the immensely dilated veins, suffer a molecular change in the histological elements of their coats, and thus become atrophied and contracted to their original calibre.

Deviations from the usual mode in which the uterus is lessened after parturition sometimes take place, and give rise to morbid conditions. Abnormal variations of this kind occur, I believe, most frequently after abortion and miscarriage, or where the general health has become enfeebled by hæmorrhage or disease. Thus the involution may be either deficient or in excess. Drs Montgomery and Simpson have described cases in which an arrest of involution had occurred, the womb being found, even months after delivery, much larger than natural, and its tissue much relaxed. In such instances, the cavity may measure four to six inches long, copious menorrhagia and leucorrhœa attending, and the affection may readily be mistaken for a tumour of the uterus, or for an hypertrophied condition of that organ. I have occasionally seen at the post-mortem examinations of women who had previously borne children, the uterine tissue affected by fatty degeneration, and so soft and friable that a sound passed into the uterine cavity during life, as a means of diagnosis, might readily have been pushed quite through the uterine walls, unless the greatest care were exercised in its

manipulation. These are probably cases where the uterus has not been pr operly reconstructed after parturition—an atheromatous condition of its walls still persisting. Whether fatty degeneration in the uterine parietes ever occurs before delivery as a morbid process, has not yet been determined; but it deserves inquiry whether some cases of rupture of the uterus have not been preceded by this condition coming on prematurely, and predisposing to the accident. Lastly, the progress of uterine involution may proceed beyond the normal limits, and what has been called by Dr Simpson 'super-involution,' produced. Thus the uterus is diminished below the usual proportions of the unimpregnated organ, and amenorrhœa and sterility are the result. Super-involution is met with more rarely than the so-called sub-involution of the uterus.

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